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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF ENTOMOLOGY.
BULLETIN No. 26.

REPORTS

OF

OBSERVATIONS AND EXPERIMENTS

IN

THE PRACTICAL WORK OF THE DIVISION,

MADE

UNDER THE DIRECTION OF THE ENTOMOLOGIST.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., January 3, 1892.

SIR: I have the honor to submit for publication Bulletin No. 26 of this Division. It comprises the reports of the field agents of the Division for the past year (1891), a summary of which has been included in your annual report.

Respectfully,

C. V. RILEY,
Entomologist.

Hon. J. M. RUSK,
Secretary of Agriculture.

REPORTS OF OBSERVATIONS AND EXPERIMENTS IN THE PRACTICAL WORK OF THE DIVISION.

INTRODUCTION.

Mr. Albert Koebele, the agent of the Division at Alameda, Cal., was sent to New Zealand and Australia early in August, and much of his time for a month or so previous to his departure was taken up with preparations for the journey. The course of experiments assigned to him was therefore interrupted, and there is no formal report from him the present season. The reports of the other agents are included in this Bulletin, including a report of the season's observations upon the Boll Worm by Mr. Mally. These reports are little more than summaries of the work performed by each of these agents. Special investigations have, from time to time, been assigned to them and upon matters of immediate importance reports have been received at different times through the year and summarized in short articles in INSECT LIFE.

Mr. Bruner's report includes only a brief account of the injurious insects which have been most prominent during the year in Nebraska. The greater portion of his time was devoted to the investigation of destructive locusts, a full account of which will be published in Bulletin No. 27.

Mr. Coquillett gives a full account of his work upon California scale-insects, and includes many new facts and the results of a number of important experiments. His report upon the work of the destructive locusts of California during 1891 will also be published in Bulletin No. 27.

Miss Mary E. Murtfeldt gives in her report her usual summary of the injurious insects of the season in Missouri and of experiments with insecticides.

Prof. Osborn, in addition to a report upon the destructive locusts of Kansas, has submitted a report upon the insects of the season in Iowa, and includes with this an account of some successful trials with a sin-

gle coal-oil pan against leaf-hoppers and young locusts, and other insects injurious to pastures.

Mr. F. M. Webster reported last year upon the development of the Hessian Fly, indicating the desirability of late sowing as a means of lessening the fall attack. He has found the present season that where this late sowing is practiced a procrastination in preparing the ground for seeding leads to the development of other injurious insects, viz, the larvæ of certain Crane-flies upon which he reports this year in full. He recommends plowing in the latter part of August or the early part of September, and refraining from seeding until later.

Prof. A. J. Cook, who was temporarily in charge of the experiments in Apiculture, reports upon a series of investigations which he carried out during the season with the help of Mr. J. H. Larrabee.

Mr. Samuel Henshaw has been engaged chiefly in work on the bibliography of economic entomology, but was requested to make some observations on the Gypsy Moth, and the report on that insect and on the work being done against it by the State of Massachusetts is also included.

C. V. R.

REPORT UPON INSECT DEPREDATIONS IN NEBRASKA FOR 1891.

By LAWRENCE BRUNER, *Special Agent.*

LETTER OF SUBMITTAL.

LINCOLN, NEBR., *October 11, 1891.*

SIR: In accordance with past custom I submit herewith a report upon the results of my labors as special field agent for Nebraska, engaged in the studies of life-histories and habits of insects related to agriculture during the past summer. In presenting this report I am pleased to be able to record a season of comparative freedom from the ravages of most of our common insect pests, but wish that it might have been even better in this respect than it has, for during years when insect depredations are comparatively light and scarcely noticeable it is safe to say that fully as much as one-tenth to one-eighth of the entire production of a country is thus destroyed.

While we have had comparative immunity from insect ravages here in Nebraska, it has not been so in some other States. Even here we have been obliged to recognize a few species as being more than ordinarily abundant and destructive. These will be mentioned briefly in the following pages.

Very respectfully yours,

LAWRENCE BRUNER.

C. V. RILEY,
U. S. Entomologist.

The present summer has been an extraordinary one for Nebraska as far as its agricultural interests are concerned. We have had abundant crops of nearly every one of our staple products, and our climatic conditions have been such as to indicate even better results for next year. But few insect enemies appeared in destructive numbers, and these few only in limited areas. Some of these are mentioned below, along with a few notes on their occurrence and habits.

MISCELLANEOUS INSECTS.

The Corn-root Worm, *Diabrotica longicornis*, appears to be alarmingly on the increase over many of the eastern counties of the State. During the past summer it has been reported from a number of new localities, and has been noted as especially numerous in some of the counties

along the Elkhorn River. Everywhere that it has been reported as uncommonly destructive investigations reveal the fact that rotation in crops is not practiced, but that corn is planted year after year upon the same grounds. This fact alone would account for its increase and spread, as has been demonstrated by repeated experiments by different entomologists as well as by farmers themselves. It had been my intention during the past summer to make special efforts to ascertain whether or not this insect had other food plants in this region, but my absence from home for the greater part of the time when this would have been under way made this investigation impossible, and it must be undertaken next year.

The Green-striped Maple Worm.—This insect continues to strip our silver maples of their leaves in the cities and towns of the State. Usually the spring brood does not appear in sufficient numbers to entirely defoliate the trees; but, as a rule, the next brood is numerous enough to do this. Thus far it has been my experience that it is next to impossible to induce the owners of property to do anything toward protecting their shade trees from the injuries of this and other insect enemies. They will do everything but the right thing, even to bandaging them with cotton (medicated) as a protection againt this and similar moths. As matters appear at present we will have an abundant crop of Maple Worms in this part of the country next year again; also a number of bared trees along the streets to advertise the ignorance of our people as to the life-history of this insect.

Lyda sp.—During the month of June specimens of the larvæ of some species of sawfly, belonging to the genus Lyda, were received from a number of correspondents residing in various portions of central Nebraska. These "slugs" were said to completely defoliate the wild plum trees of the respective localities from which the reports and specimens came. None of the mature insects were reared or received, hence I can not say to which species they belonged.

The Gooseberry Span-worm.—This insect attracted especial attention during the year. The larvæ of this moth appeared in great numbers in portions of some of the newer settled regions to the north and west of here, where in many cases they completely defoliated currant and gooseberry bushes. Over the older settled portions of the State, however, they were not reported at all. This fact is probably due to the presence of insectivorous birds and parasitic insects in greater numbers where the country has been settled for a longer time. Such is evidently the reason for having most of my inquiries come from the newer settled districts.

SUGAR BEET INSECTS.

A study of the insect enemies of the Sugar Beet has been continued throughout the spring and summer, with the results of adding several species to the list as published last year. Beyond these additions no

new facts of importance have come to light; nor do I find it necessary to change my recommendations of the use of kerosene emulsion and the arsenical sprays as remedies against the attacks of insects upon this plant.

Monoxia guttulata Lec.—This leaf-beetle has been sent to me from the Oregon Agricultural Experiment Station by Prof. F. L. Washburn, who reports it as very injurious to the Sugar Beet in the State of Oregon. He also stated that he had found three teaspoonfuls of Paris green in 4 gallons of water, in which 4 ounces of whale oil and soft soap had been dissolved, to be an effective remedy without injuring the foliage. He suggests that probably the poison would have been equally effective without the whale oil and soap.

Prof. Washburn also reports that he has taken *Hippodamia convergens* and *Diabrotica vittata* feeding on the leaves of the Sugar Beet in his State. The latter insect has also been taken here in Nebraska during the present year while feeding on leaves of both the ordinary and the Sugar Beet. *Diabrotica longicornis* has also been collected upon this plant two or three times here at Lincoln. Whether or not it feeds upon the beet, I can not say at present, since the matter has not been verified by actual observation.

Cutworms.—In the early part of the season the larvæ of several of these insects were very plentiful upon the experimental farm here at Lincoln, where they almost destroyed the entire crop of Sugar Beets growing upon two of the plats. One noticeable fact in this connection was that where there had been fall plowing and plowing again this year but few of the worms were present and consequently little injury was done to the beets growing on such portions of the field.

CABBAGE INSECTS.

Cabbage Butterflies.—These insects were not especially numerous over the State during the year, but are referred to here simply because I wish to call attention to a reported "new" remedy against them. To say the least, it is unique as well as simple, if it proves as effectual as is claimed for it. This remedy was brought to my notice about two weeks ago (September 29) while at West Point, my old home, on business connected with my work for the Division of Entomology. The remedy is simply this: The cabbage plants are sprinkled with ordinary corn meal while they are wet with dew or immediately after a rain so the meal will cling to the leaves at all points. My informant certainly had nice cabbages that were free from worms, and all he had done in the way of a preventive or remedy was to use this corn meal as above directed or explained. He claimed that in a few days after sprinkling on the meal all the worms would be found dead and turned black, clinging to the leaves of the plants. Several cabbages that had purposely been left untreated were rather full of the caterpillars of different sizes. In order to test the corn-meal remedy for myself I treated these. On

the 10th of October I received the cabbages thus treated by express just as they were when cut from the roots. The accompanying letter reads as follows:

> The worms seem to become torpid at first—at least inactive, and then seem to dry up. How the meal acts on the worms I can not say. Can not say whether they eat it by itself or whether it gets mixed up with the leaves they eat, or whether the meal that gets on them, by adhering to them, acts like poison on them. The meal does not seem to do any good unless there is a heavy dew on the cabbages and it will adhere well. Perhaps they get killed by the meal getting on them while the dew is on them. But I think not.

When the cabbages were received by me the worms were dead and partly dried up, just as they had been described to me. I do not know what to think of the matter, and give the facts as they appear here.

Eleodes tricostata.—A cabbage pest in the shape of a rather active, cylindrical, grayish-brown Coleopterous larva was noted for the first time during the past spring here at Lincoln. In some of our market gardens this larva did even more injury than was committed by the various cutworms that were quite plentiful and against which we are obliged to contend every spring. This larva not only attacked cabbages, but also showed a decided inclination to feed upon various other products of the garden. It was also found to be a general feeder both upon the prairies and in the fields where it even attacked the weeds. By placing specimens of nearly full-grown larvæ into a breeding cage it was a surprise to me when I found that from them developed the common *Eleodes tricostata.* This insect appears to be greatly on the increase here in Nebraska, and especially does it seem to be increasing over the settled portions.

While speaking of this beetle, it might be well to record the fact that I have very frequently observed attached to the elytra of *tricostata* and *opaca* the eggs of some Tachina fly. In several instances as many as three or four of such eggs were observed upon the back of a single beetle. No effort has been made by me to rear these Tachinids, nor even to ascertain whether or not the eggs had hatched, and, if so, whether or not the young maggots had succeeded in entering the bodies of the beetles.

REPORT ON THE SCALE-INSECTS OF CALIFORNIA.

By D. W. Coquillett.

LETTER OF SUBMITTAL.

Los Angeles, Cal., *October 17, 1891.*

Sir: I herewith submit my annual report for the year 1891, consisting of notes on the principal kinds of scale-insects found in this State, together with the remedies employed for their destruction.

The Fluted or Cottony-cushion Scale (*Icerya purchasi* Mask.) has been kept in subjection by the Australian Ladybird (*Vedalia cardinalis* Muls.) first imported into southern California by this Division under your direction. The propagating houses erected at San Gabriel by our State Board of Horticulture at the suggestion of its president, and especially intended to preserve these Ladybirds from being destroyed by the inclement weather of the winter season, were not stocked with the ladybirds until nearly half of the winter season had passed by; from these houses a great many colonies of these useful insects were distributed to various parts of the State during the first half of the year, but none are in either of the houses at the present time and I am informed that none will be on hand for distribution before next March. Fortunately, however, Mr. A. F. Kercheval, of this city, formerly the President of our County Board of Horticulture, infested with the Iceryas a large patch of nettles growing in the hills, several miles from any cultivated orchard, and later, after the Iceryas had become very numerous upon these nettles, he introduced a number of the ladybirds among them, so that at the present time these ladybirds can be obtained from this source in sufficent numbers to meet all local demands. In accordance with your instructions I had a tent erected over an orange tree in this city for the purpose of breeding a sufficient number of Iceryas to serve as food for the Ladybirds intended to be sent to foreign countries, since I have heretofore found it quite impossible to obtain sufficient of these for this purpose from other sources.

Respectfully yours,

D. W. Coquillett.

Prof. C. V. Riley,
U. S. Entomologist.

NOTES ON SCALE INSECTS.

In this State there is no class of insects more destructive to fruit trees than those commonly known as scale insects. Other insects may occasionally strip the tree of its leaves or rob it of its fruit, but none appear over such wide areas and cause such widespread destruction to the trees themselves as do these insidious, highly destructive pests. Up to the present time but little has been written upon the habits and

early stages of these insects. A few observations of this nature are given in the Annual Report of this Department for the year 1880, furnished by the former Entomologist, who spent a few weeks in this State during the year above mentioned. The habits and natural history of the Fluted or Cottony Scale (*Icerya purchasi* Mask.) have been thoroughly studied out and a complete account has been published by Prof. Riley in the former reports and bulletins of this Department. I have nothing new to add to what has already been written and published in regard to this pest.

The following notes upon various kinds of scale-insects occurring in this State were taken by the writer during a residence of about eight years in various parts of the State, and, although of a fragmentary nature, will still throw some light upon the habits and early stages of these pests. To these notes I have added my experience with various remedies employed for the destruction of these insects.

The Red Scale.

(*Aspidiotus aurantii* Mask.)

This at the present time is the most injurious scale-insect that our growers of citrus fruits have to contend with. As near as I have been able to learn it was first introduced into this State in the year 1879,* upon lemon trees brought from Australia and planted in one of the orange groves of this city. Mr. Alexander Craw, who formerly had charge of a large orange and lemon grove almost adjoining the one in which these infested trees were planted, informed me that when he first saw the Red Scales upon these imported trees he feared that they would prove to be a great pest, and expressed his fears to the owner of the trees, advising him to destroy the infested trees with fire. This he promised to do, but shortly afterward was taken sick and died, and the property passed into the hands of an administrator, who claimed that he had no legal right to destroy any of the property placed in his care, and therefore the infested trees were allowed to stand and the scale spread from them to the adjoining groves until it was found impossible to eradicate them.

At about the same time that these infested trees were brought to Los Angeles others from the same locality, and like them also infested with the Red Scale, were taken to Orange and planted in one of the groves there; and from these trees almost every citrus grove in that locality became infested with these pests.

The number of broods that this species produces in one season is not definitely known, and doubtless varies with the character of the season, hot weather accelerating their development, while cool weather retards it. From observation which I have made it is quite evident that in ordinary seasons at least four generations are produced in one

* Facts which we have not space to detail here make it tolerably certain that the Red Scale was introduced at least several years prior to this date.—C. V. R.

year. The adult female deposits eggs, but these are in such advanced stage of development that they usually hatch out within twenty-four hours after being deposited. I find by reference to my note book that on the 28th of May, at 4 o'clock in the afternoon, I found beneath an adult female of this species one recently hatched young scale-insect and two eggs, all of them being of a pale yellow color; one of these eggs hatched out a few hours after I found it and the other hatched out the day following its discovery. The young scale-insect from the last-mentioned egg had formed a thin white scale over it by 8 o'clock the next morning, the scale being regularly hemispherical in shape. This species evidently breeds during every month of the year. I have found adult males early in the month of March and as late as October. Early in March I have seen the young scale-insects crawling about, and by the latter part of July adult females may be found upon the green fruit, which usually sets in February or March. The greatest increase, however, occurs during the three months of July, August, and September.

While the Red Scale prefers citrus trees to all others, and probably could not maintain itself for a succession of years upon any other kind of tree or plant, still I have frequently found adults of this species upon the following plants growing in the immediate vicinity of infested citrus trees:

English Walnut,
Eucalyptus,
Acacia,
Pear,
Rose,
Camphor Tree,
Grape,
California Palm,
Date Palm,
Castor Bean,
Kennedya rubicunda,
Passion Flower,
Fuchsia,
Solanum douglasii,
Bidens sp.,
Solidago californica,
and various other weeds.

On one occasion I saw a young English walnut tree the bark of which was as thickly infested with Red Scales as any citrus tree could be; it was growing only a few yards from several orange trees on which these scales were extremely abundant.

Among the insect enemies of the Red Scale the Twice-stabbed Ladybird (*Chilocorus bivulnerus* Muls.) is perhaps the most common and widespread; I have repeatedly seen the larva of this ladybird tear off the upper scale and feed upon the scale-insect itself, and in some instances fully one-half of the scales on several of the oranges and lemons had been destroyed by these larvæ. For some reason, at present unknown, this ladybird never becomes sufficiently numerous to keep these scale-insects within due limits, even in restricted localities. About one year ago Mr. A. Kercheval, of this city, at that time president of the Los Angeles County Board of Horticulture, inclosed in a tent one of his orange trees quite thickly infested with the Red Scale, and then introduced into this tent a large number of these ladybirds, for the

purpose of ascertaining if they were capable of freeing this one tree of the Red Scales; but after waiting several months he found that the ladybirds had not made any appreciable headway against the Scales, the latter being quite as numerous as they were at the time the ladybirds were first confined in the tent with them.

In the early part of May, 1890, I found two of these ladybirds to the underside of whose bodies was attached a fungus growth of a yellowish color and very noticeable even to the naked eye. These specimens were submitted to Dr. Roland Thaxter, the Mycologist of the Connecticut Agricultural Experiment Station, who has made a special study of these low forms of plant life, and he ascertained that this yellowish fungus belonged to a new genus and species which he has since characterized under the name of *Hesperomyces virescens*. It is not probable that this fungus would ultimately have caused the death of the Ladybirds, since Dr. Thaxter writes as follows concerning the members of the group to which it belongs:

> The Laboulbeniaceæ constitute a small group of very peculiar and minute forms which have been placed by De Bary among the doubtful Ascomycetes. Their parasitism is an external one, which apparently results in little, if any, inconvenience to the host, each individual being fixed by a pedicellate attachment to the legs, thorax, or other portion of the affected insect. (Memoirs Boston Society Natural History, Vol. IV, p. 135.)

Another ladybird whose larva I have found feeding upon the Red Scale is an undetermined species of Scymnus, closely related to *Scymnus marginicollis* Mann., but having a distinct metallic, somewhat brassy tinge upon the wing cases. This ladybird measures less than an eighth of an inch in length; the head and thorax are of a light reddish color, the wing cases black, with a slight brassy tinge and thickly covered with rather short, light-colored hairs. Its larva has never been described so far as I am aware. It is of the same general form as the other ladybird larvæ, being broadest at the middle and somewhat tapering toward each end. The color varies from a brownish gray to olive brown, and in the younger individuals even to a blackish brown. In the middle of the back on segments from 4 to 7 is a lighter, somewhat pinkish stripe, darkest in the middle, and on the front part of segment 4 it is encroached upon by the dark ground color. There is sometimes a whitish stripe on each side of segments 2 and 3. Low down on each side of the body are two rows of black warts situated on whitish spots, each wart giving forth a cluster of several short whitish bristles. On the back are two rows of similar but much smaller warts, those on segments 4 to 7 being light-colored. The head is brownish gray, with the sides more blackish. The full-grown larva measures about one-seventh of an inch in length. When about to assume the pupa form it attaches the posterior extremity of its body to some convenient object and after a short time the skin splits open at the front end and is gradually worked backwards until it covers only

the last one or two segments of the abdomen, where it is allowed to remain. The pupa is of the usual form and of a very pale yellow color, except that the back and under side of the abdomen is tinged with orange yellow. The entire pupa is thinly covered with short light yellowish hairs. It measures about one-ninth of an inch in length. One of these larva assumed the pupa form on the 14th of July and was changed to a beetle six days later.

I have seen numerous thickly infested oranges and lemons upon each of which were from two to half a dozen of these larvæ, while the scales were so torn up as to give the infested fruit a roughened appearance very noticeable upon a slight inspection. I have also found this larva upon apple trees infested with the Woolly Aphis (*Schizoneura lanigera* Hausm.), and in such cases the larva frequently attaches to the bristles on various parts of its body portions of the woolly substance taken from the bodies of its victims.

Besides the larvæ of these two ladybirds, I have also seen the larva of the California Lace-wing (*Chrysopa californica* Coq.) feeding upon the Red Scale. Almost every fruit-grower in southern California is familiar with the appearance of these active, pale gray larvæ which have somewhat the appearance of miniature alligators, and provided with a pair of long, slender, pincer-like jaws projecting some distance in front of the head. In attacking a Red Scale this larva inserts its right mandible, or jaw, beneath the scale, then presses the tip of its other mandible against the upper side of the scale, thus bringing the scale-insect between the tips of its mandibles; in this way it extracts the juices of the scale through its right mandible which, being hollow, answers this purpose admirably. These larvæ feed upon a great variety of insects and their eggs, and even do not hesitate to attack each other, the stronger attacking and devouring or rather extracting the juices of the weaker ones, while the latter take this proceeding as a matter of course, never so much as making the least show at resistance. It is doubtless largely due to this cannibalistic propensity of theirs that these highly beneficial insects do not become more numerous and render greater service to the horticulturist by destroying the noxious insects that infest his trees and plants. Their numbers are also still further decimated by the attacks of internal parasites. From the larvæ and pupæ of this Lace-wing I have bred no less than four different kinds of these parasites, only one of which, the *Isodromus iceryæ* Howard, has as yet been described. These parasites seldom issue until after the Lace-wing larva has spun its cocoon. The parasitic larvæ spin no cocoons of their own, but assume the pupa form within the cocoons of their hosts, and, after being changed to the perfect or winged state, they gnaw irregular holes usually in one end of the cocoon, out of which they escape. I have bred two of the parasitic Isodromus from a single pupa of the Lace-wing, while from another pupa issued sixteen specimens of an undetermined species of Tetrastichus. Of the other two kinds of para-

sites referred to above, one of which is a Pteromalus and the other a Perilampus, only one specimen has thus far issued from a single pupa of the Lace-wing.

Besides the losses in their ranks occasioned by the attacks of these internal parasites, and the losses sustained through the cannibalistic habits of their fellows, the Lace-wings suffer still further from the attacks of spiders, which I have occasionally seen feeding upon the eggs of this insect as well as upon the adult Lace-wing itself. Notwithstanding the fact that the eggs of this insect are elevated on the tip of a slender pedicel, an evident provision of nature to protect them from the rapacious jaws of the Lace-wing larvæ, still many of them, as just stated, fall a prey to spiders and doubtless also to various kinds of predaceous insects, or even to the attacks of the Lace-wing larvæ themselves, as if nature were unable to cope with the scheming and cunning of her many children. With all of these drawbacks to contend with, it is not to be wondered at that these Lace-wing larvæ never become more numerous than they have at any time in the past. At the same time it is evidently not within our power to change the existing conditions to such an extent that these larvæ would become so numerous as to free our plants and trees of the noxious insects that infest them.

Besides the above-mentioned enemies of the Red Scale there are also other agencies not at present clearly understood, but which occasionally very materially lessen the numbers of these pests. A few years ago Mr. H. F. Gardner, of Orange, in the adjoining county of the same name, drew my attention to the fact that a large percentage of the Red Scales of all sizes upon his orange and lemon trees, as well as of the Black Scales (*Lecanium oleæ* Bern.) upon his olive trees were dead, although they had not been treated with any kind of insecticide. A close inspection of his trees revealed the fact that fully 80 per cent of the Red Scales upon these particular trees were dead, while upon the adjoining olive trees we found only a single colony of Black Scales still alive. This latter colony was in a sheltered situation and contained about a dozen individuals of all sizes. All of the other Black Scales upon the trees that I examined were dead and dry. In neighboring orange groves I also found several trees upon which fully 60 per cent of the Red Scales of all sizes were dead. Thinking that perhaps these might have been destroyed by some low form of fungus, I submitted specimens of them to Mr. Galloway, the Mycologist of this Department, with the request that they be examined for traces of such fungus, and under date of October 11, 1889, Miss E. A. Southworth, the Assistant Mycologist, wrote me as follows concerning them:

> I have examined the scales on the lemons and find that the black ones are covered with a fungus which also spreads over the fruit to some extent. Whether or not this fungus is what kills the scales I can not say positively, but I find a little of the fungus on some of the scales that seem to be living, which would indicate that it does attack the living ones and destroys them.

In reply to an inquiry for further information upon this subject Miss Southworth wrote me as follows, under date of November 2, 1889:

I think the fungus which I found on the orange scale is a *Capnodium*, although there is an unusual absence of effused mycelium, the spores appearing to be borne mainly on upright conidiophores. It is in the conidial stage and no pycnidia or perithecia are present. It is accordingly impossible to be certain of the species, although I incline to the belief that it is *C. citri*. This species has now, however, been changed to *Meliola citri*.

I do not think I stated positively that I found the fungus on *living* scales. I found it sparingly on Red Scales, but I could not be sure they were living.

The fungus referred to as *Capnodium citri* is the same kind that causes the "black-smut" on citrus and other kinds of trees, and is supposed to draw its nourishment from the excretions of various kinds of insects that feed upon the sap of these trees. It seems very probable, therefore, that this fungus would also attack the living insects themselves, although, as Miss Southworth states, we can not say positively that such is really the case.

But, notwithstanding the great number of these scale-insects that annually fall a prey to their various insect enemies, and the thousands that perish from some cause as yet not clearly understood, still these pests manage to multiply at an astonishingly rapid rate, making it necessary for owners of infested trees to employ artificial means in order to save their trees from utter destruction.

One of the most successful remedies ever used for the destruction of the Red Scale on citrus trees is the treatment with hydrocyanic acid gas, first used by the writer in the autumn of 1886. As I gave a full account of this treatment in my annual report for the year 1890, published in Bulletin No. 23, Division of Entomology of this Department, (pp. 20 to 27) it will be needless to more than refer to it in this connection.

Among the different kinds of washes that have been used for the destruction of these scales, the one giving the best results is known as the resin wash, and is fully described in my annual report for the year 1889, published in Bulletin No. 22 of this Division (pp. 10 to 17). This wash, while it does not destroy as large a percentage of the Red Scale as the gas treatment, still is fatal to the Red Spider (*Tetranychus* sp.) and also to the eggs of the Black Scale (*Lecanium oleæ* Bern.), both of which are frequently found on the same trees as the Red Scales, and neither the Red Spider nor the eggs of the Black Scale are destroyed to any great extent by the gas. For these reasons some of our fruit-growers have adopted the method of using the gas treatment and the resin wash alternately, first spraying the infested trees with the wash in July or August, which destroys the greater portion of the Red Spiders and Black Scales, as well as a large percentage of the Red Scales. Then in November or December the trees are treated with the gas, which pretty thoroughly completes the destruction of the noxious insects infesting

them. By this method the trees may be almost entirely freed of the Red and the Black Scales, so that when the oranges and lemons are gathered the following spring they will be practically free of these pests.

The Convex Scale.

(*Aspidiotus convexus* Comst.)

This scale appears to confine itself wholly to the bark of the trees it attacks. I do not remember of a single instance where I have found it infesting the leaves. Although usually attacking the Willow, on the trunk of which it frequently occurs in immense numbers, still I have also found it upon the Lombardy Poplar, Cottonwood, Walnut, and even upon orange trees. By reference to my note book I find it stated that on the 24th of April, 1890, I found a branch of an orange tree very thickly infested with these scales. The branch at its thickest part measured about 2½ inches in diameter and was covered with these scales to a distance of about 4 feet on its basal or thickest part.

This scale-insect is quite subject to the attacks of internal parasites, although up to the present time I have known of only one species thus to attack it. This is a small Chalcid fly known as *Aphelinus fuscipennis* Howard. I have bred these parasites in June and July from scales collected in the preceding April.

If it is desired to destroy these scales this can doubtless be most readily accomplished by the use of the resin wash referred to in the preceding article.

The Oleander Scale.

(*Aspidiotus nerii* Bouché.)

This species, which appears to be pretty generally distributed all over the known world, infests a great variety of plants. I have found full-grown specimens on the following-named plants and trees:

Lilac (*Syringa vulgaris*).
Arbor Vitæ (*Thuja occidentalis*), on the cones.
Century Plant, or Aloe (*Agave americana*).
Magnolia grandiflora.
Oak (*Quercus agrifolia*).
Madrone (*Arbutus menziesii*).
Nightshade (*Solanum douglasii*).
China Tree (*Melia azedarach*).
Lemon.

I do not find by my notes that I ever found these scales on citrus trees of any kind, but I distinctly remember having found them upon green lemons still hanging upon the trees, and my impression is that I also found them upon the leaves of these trees. In the Annual Report of this Department for the year 1880, the Entomologist also records having found these scales on lemons received from various sources (p. 302).

In the above-mentioned report it is stated that the eggs of this species are very light yellow in color, but I find by reference to my note book that on the 14th of June, 1883, while examining an adult female

of this species under a compound microscope I saw her produce a living young. It would be interesting to ascertain if the same species can be both oviparous and viviparous, but my subsequent notes on this species are silent on this subject.

Although I have repeatedly inclosed specimens of this species in boxes I have never succeeded in obtaining any internal parasites from them, nor can I find any published reference to parasites having been bred from scales of this kind.

The San José Scale.

(*Aspidiotus perniciosus* Comst.)

This is by far the most destructive scale-insect with which growers of deciduous fruit trees have to contend. Its origin is uncertain, but the fact of its being so frequently found upon plants imported from Japan would seem to point to that country as the home of this pest. The name of San José Scale was first applied to this species by the late Matthew Cooke, from having first received specimens of it from the neighborhood of the city by that name in Santa Clara County. It is to be regretted that any locality should be thus stigmatized by having its name applied to a pestiferous scale-insect, and it would have been far better had the later name of Pernicious Scale, first applied to this species by the former entomologist of this Department, been adopted. However, with the late Asa Gray, I do not consider it advisable to change old names.

This scale insect never attacks citrus nor coniferous trees so far as I am aware. I have examined full-grown specimens upon the following trees:

Pear,	Prune,
Peach,	English Walnut,
Almond,	Euonymus,
Apple,	And other ornamental shrubs.

The specimens from English walnut were received from Mr. Henry H. Wheeler, a prominent fruit-grower of Pomona, who writes me that he has also found specimens of this species on almond trees.

This is the only scale-insect known to me that causes a red spot to appear upon the fruit or green bark which it infests. This discoloration is usually attributed to the saliva with which the scale-insect dilutes the sap of the infested tree or fruit, but why this should produce such a discoloration in the case of the present species but not in that of any other species is no easy matter to explain. It need not be taken for granted, however, that the saliva of all the different species is identical in its composition. That of the present species may possess some peculiar, irritating principal which does not exist in the saliva of any of the other species, and therefore the effects of the attacks would not be the same in the different species.

Young branches thickly infested by this species soon present a gnarled, knotted, and stunted appearance, and if everything is favorable to the rapid increase of these scales the tree is finally killed by them. They appear to have a discrimination in relation to their food plants that is difficult to account for. I have on more than one occasion seen Leconte pear trees growing in the midst of other varieties of pear trees which were thickly infested with these scales, and yet it was impossible to find even half a dozen specimens of these scales on the Leconte pear trees. I have also been informed that the Black Tartarian Cherry tree enjoys the same immunity from the attacks of these pests, even when completely surrounded with badly infested cherry trees.

Among insect enemies the most common and widely distributed species is, perhaps, the Twice-stabbed Ladybird referred to above in the chapter treating of the Red Scale. I have frequently seen infested pear trees upon which these ladybirds occurred in large numbers, still I never knew of an instance where even a single tree had been entirely or even very nearly freed of the scales by these ladybirds. Another ladybird which also attacks the San José Scale is the small Scymnus referred to in the chapter above mentioned, but this species, like the preceding one never occurs in sufficient numbers to entirely exterminate the scales.

Of internal parasites I have bred from these scales large numbers of small, four-winged Chalcid flies known as *Aphelinus fuscipennis* Howard, a parasite that appears to be quite a general feeder, as it has been bred from at least half a dozen different kinds of scale-insects belonging to species which are protected by a shell or scale. Although occurring in such large numbers, still this parasite is not able to keep the scales in check. It doubtless breeds throughout the year, as I have bred specimens as late as the 10th of November. Although I have never bred any other kind of internal parasite from the San José Scale, still it would appear that other kinds attack it in the northern part of the State. On the 31st of March of the present year I received from E. M. Ehrhorn, of Santa Clara County, two different kinds of Chalcid flies for naming, and in the accompanying letter occurred the statement that both of these parasites had been bred from San José Scales. These parasites proved to be the Chalcid flies, known as *Aphelinus mytilaspidis* Le B. and *Coccophagus citrinus* Craw.

It appears that certain conditions of the climate affect these scales in an injurious manner, just as is the case with several other kinds of scale-insects. A few weeks ago Mr. C. H. Richardson, of Pasadena, one of the county inspectors of fruit pests, showed me several pear trees in that locality which a year ago were very thickly infested with these scales, as was evidenced by the gnarled appearance of the branches as well as by the dry scales still adhering to the trees. After a careful examination of these scales scarcely a live one could be found. Mr. Richardson assured me that these trees had not been treated with any

kind of insecticide, and they certainly gave no evidence of such treatment. The dead scales showed no indications of having been destroyed by ladybirds nor yet by internal parasites. Wishing to ascertain if this singular mortality was general among these scales in other localities, I examined several infested pear trees in this city, but found that the fruit and new growth upon them were thickly infested with these scales, which were alive and to all appearance in a very thriving condition. It would appear, therefore, that this mortality among the San José Scales was entirely due to certain climatic influences, unless it can be shown to have been due to some low form of fungus growth.

The remedy most extensively used in this State for the destruction of the San José Scale on dormant trees is the one containing lime, salt, and sulphur, described in my annual report to Prof. Riley for the year 1890 and published in Bulletin No. 23, Division of Entomology, of this Department (pp. 30 to 34). I there gave an account of a series of experiments which I had made with the above mentioned substances, both when used singly and also when used in various combinations, and expressed my intention of pursuing this subject still further the following winter with a view of improving upon the insecticidal properties of the wash used at that time. Accordingly, on the 10th of February, 1891, I made a number of experiments with the above-mentioned ingredients, and give herewith a brief account of the principal ones:

Experiment 260.—Sulphur, 30 pounds; lime, 43 pounds; water sufficient to make 100 gallons. The sulphur and lime were placed in the kettle together and water added; the whole was then boiled for two hours without first allowing the lime to slake; the solution did not assume an orange-yellow color as soon as in other experiments where the lime was first slaked before being boiled with the sulphur. Strained the solution and sprayed two pear trees with it at about 2:20 p. m.; sun shining; light breeze. Examined these trees March 26 and found a great many living San José Scales upon them.

Experiment 261.—Same as in the preceding experiment, except that before spraying it upon the trees I added 23 pounds of salt to the diluted solution and stirred it until the salt was dissolved, then sprayed a peach tree with it at about 2 o'clock in the afternoon. Examined this tree March 25 and found upon it many living San José Scales. Still, these were not as numerous as upon the trees treated in the preceding experiment, where no salt had been used.

Experiment 258.—Sulphur, 45 pounds; lime, 65 pounds, water sufficient to make 100 gallons. The sulphur and lime were first placed in the kettle; water was then added and the lime allowed to slake, after which more water was added and the whole then boiled for two hours. At first the solution was of a pale yellow color, but it soon became dark orange yellow, assuming this color much sooner than was the case in experiment 260, where the lime was covered with water and boiled without first being allowed to slake. The solution when properly diluted was strained and two apple trees were sprayed with it at about 2:40 p. m. I examined these trees March 26, and found quite a large number of living San José Scales upon them.

Experiment 259.—Same as in 258 except that when diluted ready for use I added 34 pounds of salt to the solution and stirred it until dissolved, then sprayed a prune tree with it at 3 o'clock in the afternoon. I examined this tree March 26 and found a few living San José Scales upon it, much less than in experiment 258, or any of the preceding ones.

In experiments 258 and 260 the bisulphide of lime (CaS_2) was formed, but this did not prove as destructive to the scale-insects sprayed with it as was the case where a certain amount of salt had been added to it. From this it would appear that the bisulphide does not of itself and alone constitute the insecticidal property of this wash; at the same time, my previous experiments prove that salt alone simply dissolved in water possesses very little value as an insecticide. Still, when these two substances are combined, the resulting solution possesses much greater insecticidal properties than does either of them when used separately.

In making the above experiments I was aided in the mechanical part of the work by Mr. C. H. Richardson, of Pasadena, who kindly placed his infested fruit trees at my disposal.

The first rain which occurred after the above experiments were made began on the morning of February 15, and continued almost incessantly for the space of two days and one night. Two days later this was followed by a long-continued rain. Since the solution was upon the trees for the space of about four days and five nights before the rain began, it would appear that it had sufficient time in which to act upon the scales before being washed off by the rain, and that its effects upon the scales would have been about the same had no rain occurred for several months after the various solutions were applied to the trees.

The wash used in experiment 261 is practically the same as the one in common use all over this State for the destruction of the San José Scale on dormant deciduous trees. Still, as stated above, it did not prove fatal to *all* of the scales sprayed with it. Even when used one-half stronger than this, as it was in experiment 259, it did not destroy all of the scales sprayed with it. These and other experiments which I made with this wash during the past winter confirm the opinion expressed in my preceding report, to the effect that this wash is not as effectual as the resin wash made one half stronger than when used on citrus trees. I have given a full account of this resin wash of the above strength on pages 27 to 30 of Bulletin No. 23, referred to above; so it will be unnecessary to more than give the formula in this place:

Resin	pounds..	30
Caustic soda (70 per cent strong)	do....	9
Fish oil	pints..	4½
Water, sufficient to make gallons		100

This wash can only be used upon dormant trees. Owing to the fact that in some portions of the State the winter rains interfere to a great degree with the spraying of the trees at that season of the year, frequently rendering wholly ineffectual the labor of a whole day and materially lessening the insecticidal effect of the wash used during the preceding week, it is the custom with some growers to confine their spraying operations entirely to the rainless summer season. At this season, of course, it would be impossible to use as strong a wash as

could be employed during the winter season, owing to the injury it would occasion to the foliage and blossoms or fruit. For the purpose of ascertaining how strong a wash could be used on various kinds of deciduous fruit trees during the summer season, I made, a series of experiments with resin washes of various strengths on the 4th of September of the present year. I used a wash two-fifths and also one three-fifths as strong as in the formula given above; these I sprayed upon apple, pear, peach, and prune trees a short time before the noon hour, and at a time when the sun was shining brightly, but none of the leaves on any of these trees were injured even by the strongest wash. Only the apple trees contained any fruit, but this was not injured by the wash. The stronger wash is of the same strength as that commonly used for the destruction of various kinds of scale-insects upon citrus trees in the hottest part of the summer season, and the above experiments indicate that it can also be safely used upon growing deciduous trees.

I also sprayed some of the stronger wash upon a rose bush, but the leaves on this bush were slightly injured by it; on these bushes, therefore, it would be necessary to use a somewhat weaker wash.

The Greedy Scale.

(*Aspidiotus rapax* Comst.)

This scale-insect received its name not from a voracious nature and consequent destructiveness, but rather from the fact that it infests such a great variety of different kinds of trees and plants. The following is a list of those upon which I have found full-grown specimens of this species:

Apple, Pear, Loquat, Myosporum, Birch, English Laurel, Maple, Silvertree from South Africa (*Leucadendron argenteum*), *Rhamnus croceus*, California Walnut (*Juglans californicus*), English Holly, Fuchsia, Cottonwood, Camellias from Japan, also on oranges and lemons.

The last two fruits sometimes become very thickly infested with these scales, but this seldom happens, except in the case of those allowed to remain on the trees for several months after they are ripe; in such cases I have never found one of these scales upon any other portion of the tree.

This insect was evidently imported into this State from some other country, although I can not find any reference to it in foreign countries in any work to which I have access. It is possible, however, that this is the same insect previously described by Boisduval under the name of *Kermes camelliæ*, and which has been referred to the genus *Aspidiotus* by later authors. This latter species also infests Camellias, Euonymus, and various other kinds of ornamental shrubs and trees in Europe, New Zealand, and perhaps also in other countries.

The Soft or Brown Scale.

(*Lecanium hesperidum* Linn.)

This is perhaps the most common and widely distributed of the scale-insects, being found in the four quarters of the globe, and although not infrequently occurring in large numbers, still I have never known of a single instance where a tree or plant has ever been destroyed by it. Its general effect is to weaken or stunt the infested plant and to render it black and unsightly by reason of the black fungus which always accompanies its attacks.

This scale-insect is quite a general feeder, infesting wild trees and plants as well as cultivated ones. I have found full-grown specimens on the following trees and plants:

Lombardy Poplar, Grape, Loquat, Rubber Tree (*Ficus macrophylla*), Ash, Euonymus, Maple (*Acer dasycarpum*), *Rhamnus crocea*, *Heteromeles arbutifolia*, *Rhus integrifolia*, Pepper Tree (*Schinus molle*), Willow, Apricot, Citrus trees, Fig, Locust, English Ivy, English Holly, Rose, Calla Lily, Oleander, and Pittosporum. It infests the leaves and green bark, but is very seldom found upon the fruit.

This species brings forth its young alive, although when first excluded they are still enveloped in a very thin sac, which in a short time is cast off. They remain for several days beneath the parent and then start out for themselves. The greatest number of larvæ and pseudo-ova that I ever found at one time beneath a scale of this species was twenty-four, of which number twenty-one or twenty-two were fully developed young ones. This was in the month of May, and during the same month I repeatedly found from eighteen to twenty of these larvæ beneath an adult scale.

This species is very subject to the attacks of internal parasites, of which no less than five different kinds are known to attack it in this country alone. Of this number I have bred *Encyrtus flavus* Howard, and *Coccophagus lecanii* Fitch from specimens of this scale-insect collected in this city. The *Encyrtus* attacks principally the larger scales, each of which frequently contains three or four of the parasites lying transversely to the longest diameter of the scale, and readily distinguishable by their lighter yellow color. On the other hand, the *Coccophagus* principally attacks the younger scales, only one of the parasites infesting a single scale, which it causes to swell up and assume a blackish color. I have frequently found whole colonies of these scales every member of which had been destroyed by one or the other of these parasites.

On the 11th of October, 1890, I collected several of these parasitized scales, all of which had been killed by having been subjected to the treatment with hydrocyanic-acid gas referred to in the chapter on the Red Scale, and three days later an apparently healthy specimen of *Coccophagus lecanii* issued from one of them. This parasite being in the

pupa state at the time its host was subjected to the poisonous gas, was not affected by the gas to the same degree it would have been if in the perfect or adult state, since I have repeatedly proven it to be a fact that larvæ and pupæ of insects are not affected by this gas to the same degree that the adult insects are. At the same time, when a scale is infested with one of these parasites and is sprayed with a resin wash sufficiently strong to kill the scale, this also proves fatal to the included parasite. This is one of the many advantages which the gas treatment possesses over any kind of a wash for destroying scale-insects.

Besides the gas treatment and the resin wash, both of which are referred to above in the article treating of the Red Scale, another remedy, which has the advantage of being very simple and nearly always at hand, consists of spraying the trees with a solution of common brown laundry soap—1 pound dissolved in 3 gallons of water. I have seen all of these scales on small orange trees entirely destroyed by a single application of this remedy.

The Hemispherical Scale.

(*Lecanium hemisphæricum* Targ-Tozz.)

My collection contains three different forms of Lecanium which are here commonly known under the name of *L. hemisphæricum*. The largest individuals of the largest form measure 5^{mm} long by 4 wide and 3 high; these I have found upon pear and orange trees, and also on Sycamore (*Platanus racemosus*), Wild Lilac (*Ceanothus diraricatus*) and on California Holly (*Heteromeles arbutifolia*). The largest individuals of the medium form measure only $3\frac{1}{2}^{mm}$ long by 3 wide and 2 high; these I have found only on orange trees. The third and smallest form I have found only upon the Hare's-foot Fern (*Davallia canariensis*), where they occurred in such large numbers as to kill the plant infested by them. The largest individuals measured only 3^{mm} long by 2 wide and $1\frac{1}{2}$ high. The largest form is evidently the *Lecanium hibernaculorum* of Boisduval (originally described as a Chermes), since it agrees very well with the description of this species given in *The Entomologist's Monthly Magazine*, Vol. XXII, p. 78. This description is by Dr. J. W. Douglas, who has made this group of insects his special study, and who had before him specimens identified by Dr. Signoret, the highest authority upon scale-insects. The medium form found upon orange trees is evidently the true *hemisphæricum*, while the smallest one is just as certainly the *Lecanium filicum* of Boisduval (also originally described as a Chermes). Mr. Maskell, of New Zealand, another well-known authority upon scale-insects, considers *hemisphæricum* and *filicum* as belonging to one and the same species, and is inclined to consider *hibernaculorum* as being only a larger variety of the above species; it is very doubtful, however, that he had the true *hibernaculorum* before him when making his observation, since the measurement he gives (one-ninth of an inch in di-

ameter, being less than 3mm) is much too small for my specimens and those described by Dr. Douglas. The latter author considers these three froms as belonging to three distinct species. The specimens in my own collections indicate that *hibernaculorum* is undoubtedly distinct from the other two forms, being larger, destitute of distinct lateral carinæ, and the flattened margin is much narrower than in either of the other forms. I incline to the belief, with Maskell, that *hemisphæricum* and *filicum* are but forms of one species, but to settle this point definitely it would be necessary to compare the larvæ of these various forms which as yet I have not had the opportunity of doing. Neither of these three forms are at all common in this portion of the State.

The Black Scale.

(*Lecanium oleæ* Bern.)

This scale-insect is widely distributed, being found in nearly every portion of the civilized world, living in greenhouses in the colder countries and in the open air in the warmer climates. It is not so destructive to plants as some of the other species are, and I have never known of a single instance where a tree or plant has been killed by them, although they sometimes occur upon certain trees in immense numbers. The injury caused by them is seen in a general weakening of the entire tree, which, if badly infested, is rendered unsightly by reason of the black fungus which exists upon the liquid exudations of these insects.

Citrus trees are very subject to the attacks of these scales, and the fruit of trees infested by them is rendered so unattractive in appearance on account of the black fungus above referred to that its market value is much less than it otherwise would be. Among deciduous trees the Olive and Apricot appear to be more subject to the attacks of these scales than any of the other kinds. The Black Scale, however, does not appear to be very particular as to the kind of plants upon which to gain a sustenance, as will be seen by reference to the following list of plants and trees upon which I have found full-grown specimens of this scale-insect:

Citrus trees.
Apricot.
Almond.
Sycamore.
Rhus integrifolia.
Heteromeles arbutifolia.
Oleander.
Baccharis viminalis.
Ficus macrophylla.
Habrothamnus elegans.
Guava.
Irish Juniper.
Lombardy Poplar.
Myosporum.
Melaleuca purpurea.
English Laurel.
English Holly.
Beech.
Ash.
Acer dasycarpum.
Rhamnus crocea.
Pepper Tree.
Grevillea robusta.
Ligustrum japonicum.

Indian Cedar.	*Sonchus oleraceus.*
Cedar of Lebanon.	*Cycas revoluta.*
Euonymus.	*Artemisia californica.*
Red Pepper.	*Solanum douglasii.*
Castor Bean.	Abutilon.

Quite a large number of these plants and trees in this list are wild ones, and in several instances they were situated several miles from cultivated plants of any kind. There can be little room for doubting that in these instances the scales were carried to them by birds which had visited the infested cultivated plants, and afterwards flown to and alighted upon the wild ones.

The observations which I have made upon these scales indicate that there is but a single generation produced each year. I give herewith my notes upon this subject as I find them recorded in my note books; these notes cover a period of several years, but were mostly made in Los Angeles County.

February 4.—Found a great many empty scales of *Lecanium oleæ* on orange trees on the green twigs near the terminal ends of the branches; also found a great many young ones from 1 to 1½ mm. long, some of which show the dorsal and two transverse carinae quite distinctly.

February 8.—Found several *Lecanium oleæ* about one-half grown on *Baccharis viminalis.*

February 10.—Found empty scales and a great many young of *Lecanium oleæ* on an Oleander.

March 11.—In an extended search for the eggs of the Black Scale today none were found.

March 30.—Found Black Scales about one-third grown on Indian Cedar and Cedar of Lebanon.

March 31.—Found several eggs of the Black Scale.

April 1.—Found a living Black Scale, beneath which were about fifty eggs, the first I have found this year; found no other eggs of this species after an extended search, the majority of the scales being not more than half grown.

April 3.—Found a Black Scale, beneath which were about a dozen eggs, but the most of the other specimens were not yet fully grown.

April 16.—Found a few eggs of the Black Scale.

May 21.—Eggs of the Black Scale just beginning to hatch.

June 2.—The Black Scales have deposited from one-third to one-half of their eggs.

June 3.—Beneath the largest *Lecanium oleæ* I could find on an orange tree were a trifle over 2,200 eggs and young larvæ.

June 22.—Received many Black Scales on Oleander from Santa Clara County; they were from one-half to fully grown, and several of the latter individuals covered eggs.

August 10.—Under some adult Black Scales all of the eggs have hatched out, while beneath others from one-sixth to one-third of the eggs are still unhatched.

September 22.—Found no eggs of the Black Scale after an extended search.

These observations were made upon scales living in the open air, and indicate that the greater number of the eggs are deposited during the months of May and June, although a few may be found as early as the last week in March and as late as the first week in September; outside of this period but few eggs of this species will be found. Although this

species is quite generally known as the Black Scale, still this term is an evident misnomer, at least as far as some specimens of this scale are concerned. On the 16th of April, 1890, Mr. F. O. Cass, of this city, brought me several leaves and twigs of Oleander upon which (paradoxical as this may seem) were three Black Scales of a uniform white color; some of the other scales were dark brown, while the remaining ones were of the normal brownish-black color. I submitted them to Prof. Riley, and under date of April 23, 1890, he wrote me as follows in regard to them:

> I have received a box containing white "Black Scale." I feel sure that this is *Lecanium oleæ*, but do not recollect that I have seen anything like it before. It is more probably to be accounted for as a case of albinism, which is the only case I know of in Coccids. Lecanium does not molt in this way.

I have never observed this characteristic in any other kind of scale-insect, and it appears to be of rare occurrence among the individuals of the present species.

The young of Black Scale after issuing from the eggs usually remain beneath the body of the parent for several hours, finally crawling out and taking up a position on some other portion of the plant; they do not settle down in one place permanently, but change about as circumstances may make it necessary. I have seen half-grown individuals thus crawling about. As a rule they infest only the leaves and bark; only in rare instances do they attack the fruit. The eggs first laid are hatched out before the last egg is deposited, and thus the processes of deposition and hatching proceed simultaneously until the last egg has been deposited. The number of eggs deposited by a single female is simply enormous; as stated above, I counted beneath one of them over 2,200 eggs and young larvæ, all of which were undoubtedly the progeny of this female.

Among the insect enemies of the Black Scale may be mentioned the Twice-stabbed Ladybird (*Chilocorus bivulnerus* Muls.), the larva of which I have repeatedly caught in the act of feeding upon these scales. I have also seen the larva of the Tineid moth, *Blastobasis iceryæella* Riley, feeding upon these scales. I find by reference to my note book that on the 11th of March, 1887, I found a larva of this species beneath three empty full-grown Black Scales on an olive tree; this I transferred to one of my breeding cages, in which I placed a branch of an olive tree upon which were Black Scales of all sizes. A few days later I examined this cage and found that the larva had spun a thin, loose silken web over some of the Black Scales and had partially devoured several of the half-grown ones. This larva had changed to a chrysalis when examined on the 4th of May following and the moth issued May 28. A full description of this insect will be found in the Annual Report of this Department for 1886 (pp. 484–486), and a figure of the moth is also given at Fig. 3, Pl. III, of the above-mentioned report.

By far the most effectual destroyer of the Black Scale, however, is a

small, four-winged Chalcid fly known as *Dilophogaster californica* Howard. A description and figures of both the male and female of this useful parasite will be found in the Annual Report of this Department for the year 1880, p. 368, and Pl. XXIV, Figs. 3 and 4. The name Tomocera, under which this insect was described in the above-mentioned report, was found to have been previously used for another group of insects belonging to the order Thysanura, and the name Dilophogaster was therefore substituted for it. I have quite frequently found orange trees upon which fully 80 per cent of the adult Black Scales had been destroyed by these parasites. I find by reference to my note book that I bred parasites of this kind on the 14th and again on the 27th of June from Black Scales collected on the 25th of the preceding April; and that on the 22d of September I found a full-grown larva of this parasite under an adult Black Scale. I also captured specimens of this Chalcid on the following dates: January 17, July 2, August 31, September 21, and October 12. This would seem to indicate that at least two and perhaps even three generations of these parasites are produced in one year.

It is to be regretted that these useful parasites sometimes fall a prey to other insects, but such is the case. I find by reference to my note book that on the 21st of September I saw a larva of a slender greenish bug known as *Diplodus renardii* Hol. engaged in feeding upon one of these parasites; the beak of the larva was inserted into the body of the Chalcid fly and the juices of the latter had been nearly extracted by the voracious captor. Fortunately, these predaceous insects are not abundant. I have occasionally seen them preying upon other kinds of Chalcid flies besides the Dilophogasters; on the 1st of September I captured one of the adults which had its beak inserted into a *Perilampus* sp., one of the Chalcid parasites of the Lace-wing referred to above in the chapter treating of the Red Scale; the Diplodus held the Chalcid beneath his front feet, somewhat as a dog holds a bone while gnawing it. I have occasionally found the square or roundish egg masses of this Diplodus attached to the upper surface of the leaves of orange trees; each mass contains from thirty to forty eggs which are regularly arranged in rows, the eggs in one row alternating with those on either side of it. Each individual egg is nearly cylindrical in form, of a honey-brown color, except the top, which is white, and near its center is a small puncture as if made with the point of a needle. The mass is fastened to the leaf by a very sticky substance, which, however, does not hold it firmly, and the egg mass may be easily removed from the leaf with the thumb and fingers of one hand. The adult Diplodus measures nearly half an inch in length, is rather slender, and of a yellowish-green color variously marked with black and yellow.

Notwithstanding the immense numbers of Black Scales and their eggs which are annually destroyed by the Dilophogasters, still these scales frequently become so abundant as to render it necessary to em-

ploy artificial means in order to rid the trees of these pests. For this purpose the treatment with hydrocyanic-acid gas and the resin wash, both of which are referred to above in the articles treating of the Red Scale, are also employed for the purpose of destroying the Black Scale. The gas treatment proves fatal to the scales, but does not destroy all of the eggs. The resin wash destroys the greater number of the eggs and also of the younger scales that it reaches, but it does not always destroy the larger individuals. On the 6th of November, 1890, I had eleven olive trees sprayed with the resin wash made according to the following formula:

Resin	pounds..	18
Caustic soda (70 per cent strong)	do....	5
Fish oil	pints..	2½
Water, sufficient to make	gallons..	100

The Black Scales infesting these trees were less than one-third grown. I examined them on the 13th of December, and found that nearly all of the scales were dead, those still alive having to all appearance escaped being sprayed with the wash; the leaves and fruit upon these trees had not in the least been injured by the wash.

On the 22d of September of the above-named year I sprayed a small olive tree with a wash made in accordance with the above formula, and after carefully examining the Black Scales upon it on the 21st of the following month I found only a single living scale, while the leaves on the tree were uninjured. On the 6th of January of the present year I was shown an Abutilon plant thickly infested with Black Scales, and was informed that it had been quite recently sprayed with a wash practical'y the same as that described above; still quite a large percentage of the oldest scales had not been destroyed by the wash. It would therefore be advisable to spray the trees at a time when the scales are very young; this period in ordinary seasons extends from about the first of October to the beginning of the new year.

In place of the above wash, some of our fruit growers use one which contains no fish oil, being composed simply of resin, caustic soda, and water. This, besides being cheaper than the preceding wash, is also less troublesome to make, and while it is not so effectual as the former wash, still it proves fatal to a large percentage of the younger Black Scales. One of my correspondents, Mr. C. B. Messenger, of Pomona, in a letter to me bearing date of March 31, 1890, gives his experience with a wash of this kind as follows:

> Last year some of the trees I sprayed in midsummer with a wash consisting of resin, 25 pounds; caustic soda, 6 pounds, in 100 gallons of the wash, were almost perfectly cleaned of Black Scales, but I now find that the fruit, or rather a small portion of it, was made unsalable by the solution giving the oranges a russety appearance. Sometimes the whole orange is thus affected, but usually only in streaks where the solution collected and ran around to the under side, where it was the worst. The spraying did not act in the same way on the fruit in the other orchards, although the same strength of wash was used throughout the season. The present work was followed by very hot weather. Was this the cause of it?

I have often noticed, and in my writings have frequently called attention to the fact, that when used in very hot weather all washes are more liable to injure the tree or fruit than would be the case if used in cooler weather. For use on bearing citrus trees in very hot weather no wash should contain over 5 pounds of 70 per cent caustic soda in 100 gallons of the wash; if a greater quantity than this is used at such times there is great danger of marking the fruit in the manner above described. When only resin and caustic soda are to be used, 5 pounds of the latter and 18 pounds of the former in 100 gallons of the wash is as much as should be used in very hot weather on bearing citrus trees. I have never known of a single instance where a wash of this strength has marked the fruit even when used in the very hottest part of the summer season.

It is interesting to note that the wash used by Mr. Messenger is precisely the same as the one I used on the 7th of August, 1889, in my experiments 199 and 200, an account of which I gave on page 15 of Bulletin 22, referred to above. I there recorded the fact that the wash had produced rusty, brownish spots upon the young oranges, just as Mr. Messenger also found that it would do.

In traveling about over the southern portion of the State I have frequently noticed that the Black Scale thrives best near the coast, and that in the hot, dry interior valleys a large percentage of them are destroyed by the extreme heat. Even in localities not far from the coast, large numbers of the younger scales perish during the excessively hot weather that sometimes occurs during the months of July and August. In fact, in almost any locality these scales will be found in the greatest numbers upon trees having a dense foliage, or which are so situated as to be more or less shaded from the direct rays of the sun. For this reason a judicious use of the pruning knife will accomplish much in the way of preventing trees from becoming unduly infested with these scales, while at the same time it will cause the tree to be in a better condition for being treated with artificial remedies.

The Frosted Scale.

(*Lecanium pruinosum* Coq.)

Since writing up the account of this species which appeared in Insect Life, vol. III, pp. 382–384 I have made but few additional notes on this species. One new food-plant must be added to the list given in the above-mentioned account; this is the common Cork Elm, quite largely grown for ornamental purposes, especially in the northern part of the State. On the 24th of May I received twigs of this tree thickly infested with Frosted Scales; these were sent by Mr. G. W. Harney, President of the Yuba County Horticultural Commission; and during a recent visit to Marysville Mr. Harney showed me the original tree from which these scales had been taken. Several of the branches on

this tree were very thickly infested by the scales, indicating that the tree is perfectly congenial to their tastes and requirements.

In the above-mentioned account I stated the fact that at that time no insect was known to attack these scales, but since this was written I have bred from them numerous specimens of a small Chalcid fly, known as *Coccophagus lecanii* Fitch. These attack only the younger scales, and only one of the parasites infests each scale, causing the latter to assume a more convex, much smoother form than when not parasitized, and the entire upper portion of the parasitized scale becomes black.

The Brown Apricot Scale.

(*Lecanium* sp.)

In the Santa Clara Valley, south of San Francisco, occurs a species of Lecanium which is sometimes very destructive to various kinds of deciduous trees. On the 21st of March of the present year I received specimens of these scales from Mr. F. M. Righter, an extensive grower of deciduous fruits located in the above-mentioned valley. The scales were of two sizes, representing two different generations, the old dead and dry females and the nearly half-grown young ones. A careful examination of these specimens convinced me that while they were evidently closely related to the Frosted Scale of the preceding chapter, still they evidently belonged to a distinct species. The more marked differences consisted in the smaller size of the adult females, the fact that they never became covered with a whitish powder, and the further fact that the younger ones are destitute of the submarginal row of long bristles which occur in the young of the Frosted Scale.

In the letter which accompanied these specimens Mr. Righter writes as follows concerning them:

> I send you by today's mail specimens of the Brown Apricot Scale, so called, notwithstanding they infest prune trees as much or more than apricot. They are also found on peach, pear, apple, and cherry, but principally on apricot and prune. * * * I think they are not the same as the Brown Scale you mention; they are never covered with a white powder.

Thinking that perhaps the submarginal bristles may have existed in perfect specimens of the young scales but had been accidently broken off of the specimens sent me through the mails, I requested Mr. Righter to examine the young scales fresh from the tree and ascertain if these submarginal bristles existed upon them; and under date of April 18, 1891, he writes me as follows:

> I have a microscope of very high magnifying power, and have carefully examined both the young and the full-grown scales, and find that neither of them are provided with bristles around the edge of the body. Nor can I find any as large as you mention, *i. e.*, seven twenty-fifths of an inch in length; the largest I can find measure seven thirty-seconds of an inch in length.

Again, under date of May 12, he writes as follows:

> The Brown Apricot Scale seems to have completed its work. Its eggs are laid, and it is seemingly wholly inactive.

The largest adult specimens received from Mr. Righter are 4mm long by 3 wide and 1¾ high, and the smallest adult specimens are 3mm long, 2 wide, and 1 high; the color is a light yellowish brown, the outline oval, narrowing anteriorly; the sides are rugose and transversely carinate, the dorsum much smoother, and with indications of a medium carina most distinct anteriorly; the edges are thin and spread out.

My library contains references to upwards of fifty descriptions of as many different kinds of Lecanium, and it is quite impossible to decide to which of these numerous species the Brown Apricot Scale belongs.

As a remedy, the stronger resin wash described in the chapter on the San José Scale will doubtless be found effectual when used against the present species; it should only be used while the trees are dormant, and at that time none but the younger scales will be found alive, there being but a single generation each year. Common brown laundry soap, 1 pound dissolved in 3 gallons of water, will doubtless prove fatal to these scales, as I have known it to do when applied to the common soft Brown Scale.

THYMO-CRESOL AS AN INSECTICIDE.

Some time during the past summer I received a can of thymo-cresol for experimental purposes. No opportunity occurred for testing this insecticide until on the 4th of September, at which date I sprayed some of the diluted liquid on an orange tree infested with the Yellow Scale (*Aspidiotus citrinus*) and with the Soft Scale (*Lecanium hesperidum*). I used it in the proportions of 1 gallon to 1,000 gallons, and also to 2,000 gallons, of the wash, these being the proportions recommended for destroying scale-insects on orange trees as given in the circular which accompanied the can of insecticide. The weaker wash did not prove fatal to a very large percentage of the scales, but the stronger one destroyed about 90 per cent of them; there were very few of the soft scales on this tree, but all of them were destroyed by the wash, while the fruit and leaves were not injured. In the printed directions it is recommended to syringe the trees with pure water fifteen minutes after applying the wash, but this I did not do, since it would occasion too much labor to carry out this plan in the case of large orange groves.

According to a schedule of prices which accompanied the can, a 3-gallon can of the thymo-cresol costs $5.25; at this rate, each gallon of the stronger wash used above would cost somewhat less than one-fifth of a cent per gallon, which would make this an extremely cheap insecticide.

In the printed directions it is recommended to make three applications of this wash, at intervals of eight or nine days, each application to be followed by a spraying with pure water fifteen minutes after the application is made; this plan might be followed in regard to a few plants or small trees, but it is altogether too expensive for adopting in the case of large orange groves.

ENTOMOLOGICAL NOTES FOR THE SEASON OF 1891.

By Mary E. Murtfeldt.

LETTER OF SUBMITTAL.

Kirkwood, Mo., *October 31, 1891.*

Sir: I herewith inclose a record of some of my observations and experiments for the past year relating to economic entomology.

Respectfully yours,

Mary E. Murtfeldt.

Dr. C. V. Riley,
Entomologist,
U. S. Department of Agriculture.

Taking one locality with another, this State may be said to have suffered less from the ravages of insects during the season of 1891 than for many years previous. The climatic conditions from early spring until the middle of August, a period covering the growing season of the most important crops, was exceedingly favorable to the perfection of vegetation. As a consequence, the yield of grain, hay, fruits, and many sorts of vegetables has been abundant and the quality unsurpassed.

In certain localities there were irruptions of injurious insects which for a time caused anxiety, but these were, as a rule, over limited areas, and the aggregate of loss occasioned by them was less than had been anticipated.

The most annoying pests of the spring and early summer were Aphididæ of numerous species. The punctures of the fruit-infesting forms produced on the new growth of grapes, peaches, and plums considerable blight and deformity.

The Woolly Aphis of the Apple (*Schizoneura lanigera*) is an almost invincible enemy of young orchards in some sections of the State, especially on gravelly soils. On such specimens of diseased roots as were sent to me I could find no trace of parasites or other natural enemies. Drenching with strong, hot soapsuds was recommended, and was reported as quite successful in checking the work of the insect, but in some of the orchards the roots were so warty and diseased that recupera-

tion was impossible, and uprooting and burning the trees seemed the only advisable plan to pursue.

The Grain Aphis (*Siphonophora avenæ*) was sent to me from several localities, but its appearance was by no means general, and the oat crop, which in Missouri suffers most from this insect, was good in almost all parts of the State.

The Chinch Bug (*Blissus leucopterus*) appeared in considerable numbers in the western and southwestern parts of the State, first on wheat, which it did not materially injure, and later on corn, some fields of which were seriously damaged. The dissemination of the germs of so-called "chinch-bug cholera," by Prof. Snow, of Kansas, and Prof. Forbes, of Illinois, was actively carried on, and the confidence of farmers in this natural remedy for the most serious pest of their grain fields was proved by the extent of the demand for the diseased bugs. Probably not all made use of the latter in a way to accomplish the ridding of their fields of the bugs, but so far as I have been able to learn a very encouraging measure of success attended the introduction of the disease germs into infested wheat and corn fields.

The Joint-worm (*Isosoma grande* Riley) appeared in several sections of the State about the first of June and excited much apprehension for the safety of the wheat crop. In the samples of grain sent me the larvæ were invariably working in the heads, then just in bloom. None were found in any of the lower joints. Infested heads were, of course, utterly destroyed, as from three to six worms were often found in one head. Mr. J. F. Iles, of Lexington, found about 80 per cent of the heads injured in a certain field, and anticipated the loss of his crop, but later he informed me that the damage was mainly confined to a portion of a field that had been planted on wheat stubble of the previous year. The specimens reared from larvæ sent me were all females, and but one head contained pupæ that had the appearance of being parasitized, but I was not able to obtain the flies of the latter.

The Plum Curculio (*Conotrachelus nenuphar*).—Notwithstanding the almost total failure in this locality of all cultivated and most of the native stone fruits, for the two preceding years, this hardy and adaptive insect presented itself this season in sufficient numbers to inflict considerable damage upon the sweet cherries, early plums, and freestone peaches. On the latter, however, its work was not disastrous, and the later varieties escaped with very few punctures. The fruit that tided it over last year was probably the Wild Black Cherry (*Prunus serotina*) and possibly some of the pip fruits, although I have never reared it from any of the latter. I have, however, repeatedly bred it from larvæ in gooseberries.

The Harlequin Cabbage Bug (*Murgantia histrionica*) was not only unusually destructive to cabbage, cauliflower, and other cultivated Cruciferæ, but in the southern counties attacked beans, peas, and several other sorts of vegetables. This pest seems to be steadily advanc-

ing northward and has now reached about the middle of the State, having been sent to me from Phelps, Washington, and Boone counties. The mature bugs are long-lived, and my correspondents claim that eggs, young larvæ, nymphæ, and perfect insects are contemporaneous throughout the season, and that wherever they abounded the cabbage crop was almost, or quite, a failure. With a view to test insecticides upon them, I obtained in July, from Phillipsburg and elsewhere, several lots of the mature insects. Many of these had deposited their beautiful egg-clusters in the boxes by the time they reached me. There was considerable variation in the intensity of the markings of these eggs, some being very dark, while others had the black lines but faintly indicated, and one set of about a dozen was entirely pearl white. The young bugs hatched in the course of two or three days, emerging through the lids of the little "barrels," which were lifted on one edge, the shell retaining its form and ornamentation after giving up its inmate.

Part of the young bugs were transferred to plants in the garden confined under wire screens, while others were retained in the breeding cages.

The insecticides experimented with were X. O. dust and Pyrethrum, neither of which made much impression, and arsenites of ammonia in the proportions of two tablespoonfuls to a gallon of water. This killed some of the young bugs, but also severely burned the plants, and would not, in any case, be safe to use on such a vegetable as cabbage. Kerosene emulsion killed the young bugs but did not affect those that were full-grown. Thymo-cresol—one part to thirty of water—a very strong solution, was also of no avail. Hot water was then used, taken boiling from the range, carried about 100 yards to the garden, transferred to the sprinkling can and immediately applied to the infested plants. The temperature was not taken, but it could not have been much below 150° Fahr. The plants were but slightly wilted, and the bugs were all killed. In this experience all my correspondents who have tried the remedy concur. The only difficulty is to bring this, or any other application in contact with all the insects, as they seem to prefer feeding on the undersides of the leaves. But if the drenching with hot water be supplemented by careful hand-picking, two or three times during the season, the pest may be temporarily eradicated.

Cutworms this season gave far less trouble than usual. I am convinced that warm, wet winters do not agree with them. *Nephelodes violans* was the only abundant species. This was found in hay fields eating the stalks and blades of timothy grass.

Orsodachna atra Ahr.—This Chrysomelid was observed early in April, on the grounds of a neighbor, swarming on the blossoms of the peach. It would crowd into the unfolding buds, tear open the anthers, and devour the pollen proceeding from blossom to blossom with great rapidity, destroying every anther in its progress. In their haste and

greed these beetles would accumulate considerable pollen on their heads and fore tarsi, and it is probable that some of this was brought in contact with the stigmas, but there was every reason to fear that they would devour the lion's share of the golden grains and that the ovules would not receive enough to fertilize them. A few days later I found a considerable number of the same beetles at work on an isolated tree on our own place, and as the variety of peach was not very choice, it afforded a good opportunity to test the result of the insect attack. They were accordingly suffered to cut as many anthers as they would. As a matter of fact, this tree, though young, vigorous, and favorably situated, and covered with blossoms in the spring, bore very little fruit, while others of the same variety, on which Orsodachna had not been seen, produced abundantly. Should it become a pest in future years, its habit of dropping to the ground when disturbed would enable fruit-growers to destroy it by jarring it down upon cloths or trays moistened with kerosene.

The Cottony Maple Scale (*Pulvinaria innumerabilis*).—The vanguard of the hosts of this pernicious Coccid appeared again in St. Louis during the past summer upon the trunks and branches of various trees and shrubs in the parks, and in many private grounds, and unless timely attention is given to the matter it will next year prove as annoying and destructive as it was six or seven years ago.

The Post Oak Coccid (*Chermes* sp?).—The clusters of globular female scales of this insect were to be found in the axils of almost every twig and leaf of the Post Oak (*Q. obtusiloba*) during the past summer. These, in connection with an undetermined fungous disease, produced a remarkable blighting of the new growth, and in a number of cases seemed to be the cause of the death of the tree. So noticeable was the effect in the forests around Kirkwood that many people contended that it was "locust year," and wondered why we had not noted the shrilling of the Cicada. It was with difficulty that I could make them believe the contrary.

My attention was not attracted to this insect sufficiently early in the season to enable me to observe its development, and at present the scales contain only a mass of empty shells or skins. No guest insects were bred from them during the season.

The White-marked Tussuck-moth (*Orgyia leucostigma*).—The larvæ of this insect were very destructive to the foliage of Willow, Walnut, Chestnut, Maple, and some other shade trees of the streets and parks of St. Louis, as well as to Apple and Plum in private grounds, but I noted in it a habit which will (or might) enable those suffering from its ravages to destroy a large proportion of the eggs, namely, the trapping of a great number of the caterpillars as they were seeking a hiding place in which to spin, by the cotton bands with which so many of the trees that shade the sidewalks are encircled. Some of these bands that I have examined have been quite crowded with the chrysalids and egg-

masses of the insect, and, if removed and burned before spring, will certainly prevent the development of myriads of the pest. From young larvæ sent to me last spring I reared several parasites (*Limneria flavicincta*, Ashm.), but these were not sufficiently numerous to materially reduce the numbers of the host insect. If the infested trees be sprayed with Paris green, in the proportion of 1 pound to 300 gallons of water, or a very dilute solution of arsenites of ammonia, 1 pint to 100 gallons of water, the insects will be killed without injury to the foliage of any tree.

Chamyris cerintha Treat.—The singular larvæ of this beautiful moth were taken this summer feeding on the foliage of the Damson Plum. They devour the leaf on both sides to the mid-rib, leaving the latter. I think they have not heretofore been recorded among insects that depredate on the foliage of fruit trees.

Catocala grynea is becoming with us quite a serious orchard pest during the latter part of May and June. The larvæ rest during the day, closely appressed to the trunk and larger branches, and feed at night. Spraying with Paris green is an effectual remedy.

Edema albifrons, which has not been found here for a number of years, made a serious attack on the white and post oaks early in the summer, inflicting considerable injury on the foliage. No experiments were made in the application of artificial remedies.

SOME OBSERVATIONS ON THE FOREST TENT-CATERPILLAR.

While on a visit to Minnesota in May I had an opportunity of witnessing a remarkable outbreak of the above-named insect (*Clisiocampa disstria* Hbn.). In all the forests around Minneapolis, and especially on the fine trees along the shores of Lake Minnetonka, the oaks, elms, lindens (*Tilia*), and ash trees were entirely stripped of their young leaves, the larvæ migrating from tree to tree as fast as the latter were defoliated. Many would descend by the trunk, but a large proportion preferred to leave the tree by means of silken ropes, often stretched from the highest branches to the ground, and which, by the thread contributed by each descending worm, became eventually as thick as packing cord and very strong. Down this the worms crawled in single file. In driving along the woodland roads these long swaying strings of worms presented a most singular spectacle. Occasionally one of these ladders would be carried by the wind (or possibly by the accidental impact of a bird) from one tree to another, and even across the roads, forming festoons of crawling worms through which it was anything but agreeable for nervous people to drive.

The few orchards of that part of the country were also badly infested by the same species.

I could not observe much of the tent-making habit. Even when molting in companies the larvæ merely spun mats of silk against the

bark of the tree and in very few cases was there any attempt at a shelter.

From accounts in the papers of that date it would seem that the insect prevailed throughout the forests of the Northwest, and in some instances, while moving in armies from one locality to another, they were so numerous on railroad tracks as to occasion delays and stoppage of trains. Poultry refused to feed upon them, and, so far as I was able to observe, very few birds attacked them. My stay was not sufficiently prolonged to enable me to ascertain what proportion of the larvæ were destroyed by parasites. I was informed by friends who were summering at Lake Minnetonka that one still, warm evening early in July all the moths seemed to issue at once and were so numerous that the fluttering of their wings up and down the trunks of the trees and among the branches filled the air with a distinct and peculiar humming sound that attracted very general attention and curiosity.

On the succeeding evening scarcely a moth could be seen, and it was supposed that the brisk wind that blew during the day had carried them into the lake. So far as I could judge by their behavior in the rearing cage, they develop with remarkable regularity, hatching, molting, and transforming simultaneously, so it is probable that in one or two evenings of winged existence they had fulfilled their mission of providing for the continuance of their kind.

NOTES ON SOME NATURAL ENEMIES OF PERNICIOUS INSECTS.

The Web-worm Tiger (*Plochionus timidus*) (if I may be permitted to give it a popular name) realized all that was anticipated of it this season in its work of exterminating the insect it has selected for its special prey.

June 6 I found two colonies of *Hyphantria cunea*, one on a young tree of Box Elder and the other on a vigorous sprout of Laurel Oak, both in excellent position for observation *in situ*. The larvæ in each case had inclosed but two or three leaves and seemed to be about ready for the first molt.

On the 10th a single specimen of Plochionus was observed running up and down in each of these webs. On the 16th a close examination of the nest revealed a dozen or more of the slender white eggs attached to the twigs and petioles of the leaves and a few laid loosely in the web. On the 20th larvæ about 3^{mm} in length were seen in the web and probably others had attached themselves to the Web Worms, now about 11^{mm}, or one-half inch in length.

When next visited, June 23, the colony on Box Elder had migrated and separated into three companies on different parts of the tree. They had not, however, in this way escaped their relentless foe, for a number of the active little Carabids were running about among them apparently quite at home wherever the worms were. Two were seen

with their jaws buried in the bodies of the Hyphantria larvæ just back of the head.

June 27, the presence of this savage and persistent enemy seemed to utterly "demoralize" the web worms, causing them to repeatedly "break up housekeeping" and seek new locations, separating into smaller and smaller groups in the instinctive search for safety. But the attempt is vain; for no sooner are they established than Plochionus is on the trail, and is not long in discovering their whereabouts and biting into them whenever it is hungry.

By the end of June the colonies on both trees, though not nearly full-grown and greatly reduced in numbers, had dispersed, the gregarious instinct having evidently been lost much sooner than usual. A few Plochionus larvæ about one-half size were to be seen in the deserted webs for a day or two after the web worms had disappeared, after which they, too, departed, and I presume descended to the ground, where they preyed upon such larvæ as could be found there. A few were placed in a rearing jar and supplied with Spilosoma, Orgyia and other hairy larvæ, but these were not attacked, nor was I able at the time to find any other species upon which they would feed, and all perished without completing their development.

The second brood of Hyphantria, which with us has always been most numerous and injurious, was very sparsely represented in this locality. Upon my return from the East I made diligent search in Kirkwood and vicinity for the remains of webs or other evidence of the worms, but could find very few. To my mind there is no question that this happy immunity is due primarily to the agency of the little Carabid, which has in some way suddenly acquired the habit of preying upon them.

Uropoda americana.—About the middle of July I received from Mr. F. M. Webster a few specimens of the Striped Cucumber Beetle (*Diabrotica vittata*), thickly infested with the above-named large brown mite, with the request that I attempt to colonize it on the same or allied species of beetles here. Just at that season I could find but very few examples of *D. vittata*, but as *D. 12-punctata* was abundant I hoped the mites would accept the latter as a substitute. In this I was disappointed, the parasites refusing to leave their original hosts. After a few days two or three specimens of *vittata* and several each of *Colaspis prætexta*, *C. tristis*, *Lema trilineata*, and *Doryphora 10-lineata* were introduced into the jar and each supplied with its preferred food. The jar—a large one of clear glass—was kept on my desk under constant observation, and in two days I noticed a few of the mites on each species of Colaspis, with a very evident preference for the pretty blue *tristis*. In the course of a week all the specimens of the latter were thickly covered and much weakened, while only a few were found on *prætexta* and none at all on any of the other species, not even on the fresh specimens of their original host. In accordance with a suggestion, the attempt was made

to colonize them upon *Anasa tristis* and other Hemiptera, but without success.

A few of the mites had, when first received, been introduced into the cucumber bed, and upon leaving home in August I transferred all the beetles to the garden in the hope that they would disseminate the parasite. To what extent this has been done I can not now say. Upon my return home, after an absence of a month, I found the garden suffering from heat and drought, the cucumber plants nearly all dead, and no mite-infested beetles to be seen. I hope, however, that Uropoda may reappear next season in time to save us, in a measure, from the attacks not only of the cucumber beetle, but from those of Colaspis on flowers and grape foliage, on which both the bronze and the blue species have for several years inflicted much damage.

The Cabbage-worm Parasite (*Apanteles glomeratus*).—It is with great satisfaction that I announce the advent into Missouri of this valuable natural check to the ravages of *Pieris rapæ*. It was observed about the 1st of August in the gardens of Kirkwood, and about the same time was reported to me by Mr. C. P. Fox, of the experiment station at Columbia, in this State. Mr. Fox claimed that in his locality it had destroyed about 80 per cent of the worms. Unfortunately many of the cocoons received from this gentleman were infested with a secondary parasite (*Tetrastichus* sp.?) which may interfere somewhat with its future abundance. In this vicinity the primary parasite was unmolested, but was not so numerous as at Columbia, not more than one in five or six of the worms being affected. It was found, also, upon two larvæ of *P. protodice*, which in our garden were feeding upon Sweet Alyssum. It has been several years since I found the latter larvæ upon cabbage. In some unexplained way *P. rapæ* seems to have driven them from the field.

I have not yet learned how general the appearance of the cabbage-worm parasite was during the past summer in this State, but, judging from the fine crop of cabbages sent to our city markets from the northern and western counties, the vegetable must have been rescued by some natural agency from its most serious enemy, and this agency, I strongly suspect, was the little Apanteles under consideration.

INSECTICIDES.

The only new preparation experimented with this summer was "Thymo-cresol," Lawford Bros., importers, Baltimore, Md. This fluid is offered to the public more especially as a "cold-water dip" for sheep and for use on poultry and other animals in the case of vermin. It is also claimed to be a valuable disinfectant and antiseptic. In accordance with instructions from the Department it was tried as an insecticide in the place of kerosene emulsion. Added to 50 parts of water it forms a milk-white, soapy fluid that distributes readily through the Lewis hand sprayer. It has no disagreeable odor, a point that counts

in its favor, and is not irritating to the skin, nor in any degree poisonous.

The first use made of it was against that worst of all poultry pests, the Chicken Louse (*Goniocotes hologaster*). This is a minute creature, much resembling the Red Spider so injurious to plants. It is often found in birds' nests and is probably in this way communicated to chickens. In the case in question these lice not only appeared in the chicken house, but invaded the adjacent stable, where they proved extremely irritating to not only the horse, but to the person in charge. As soon as the matter was mentioned at the house measures were taken to exterminate the pest. The chickens and other animals were excluded from their usual quarters and the buildings fumigated with burning sulphur. This was followed by a thorough dusting with air-slaked lime, usually a dependable remedy. In this instance, however, these measures did not suffice to expel all the lice, and complaints of the nuisance continued. As a last resort the Thymo-cresol, a package of which had just been received, was recommended, and a large quantity ot water was prepared with the proportions of the remedy according to instructions. With this the chicken house, inside and out, and the entire stable was thoroughly drenched by the aid of the appliance mentioned above, and there was no further trouble with the louse.

As a disinfectant its use was continued throughout the season in the barn and outbuildings.

As an insecticide my experiments would not justify me in recommending it for general use. It was tried upon the beetles and larvæ of the Potato-beetle; upon the Squash Bug (*Anasa tristis*); upon the Twelve-spotted Cucumber Beetle (*Diabrotica 12-punctata*); upon the Harlequin Cabbage Bug (*Murgantia histrionica*), and upon a number of other Coleoptera and Hemiptera without appreciable effect. Various Aphididæ were destroyed by repeated applications; the larvæ of the Cabbage Butterfly were also sickened by two or three doses, but a single wetting did not suffice to do much good; a strong solution—1 part to 30 of water—was used upon Harris's Apple Scale (*Chionaspis furfurus*) and upon the Rose Scale and seemed to penetrate to and destroy the eggs; but on the whole it is not sufficiently drastic to kill at once by contact, and is not speedily poisonous to vegetable-feeding insects if taken in with the food. Its effects on vegetation are not injurious, except when a number of applications are made in succession without spraying with pure water to rinse it off. I hope to repeat and extend experiments with it another year, especially to give it a thorough trial on animal parasites, for which but little opportunity offered the present season.

REPORT OF PROGRESS IN THE INVESTIGATION OF THE COTTON BOLL WORM.

By F. W. Mally.

LETTER OF SUBMITTAL.

SHREVEPORT, LA., *October 9, 1891.*

SIR: At your request I have hastily prepared a very brief and condensed summary of this season's work, carried on under your direction, upon the Cotton Boll Worm (*Heliothis armigera* Hübn.).

All details as to experiments, observations, and special notes have been omitted, as the summary was only to give an adequate idea of the present condition of the investigation.

Very respectfully, yours,

F. W. MALLY,
Assistant.

DR. C. V. RILEY,
Entomologist.

GEOGRAPHICAL DISTRIBUTION AND DESTRUCTIVENESS.

The Boll Worm is found throughout the whole cotton region. Over the greater portion of this area its injury is only slight and not worthy of special economic consideration. The regions where special remedial or preventive measures are practicable comprise that portion of Texas included by an irregular line drawn from Paris to Tyler, to Cameron, to Temple, to Gainesville, to Paris. For Arkansas a narrow belt from Fort Smith to Morrillton, to Little Rock, to the southeastern portion of the State For the Indian Territory a strip running from Gainesville, Tex., to Fort Smith, Ark. These are the areas of greatest destructiveness, and for the whole area the injury may range from 10 to 15 per cent of the whole crop. For certain counties the percentage of injury is greater. Again, individual plantations may be almost wholly destroyed while a dozen others adjoining may escape with only slight injury. The sensational reports of damage are nearly always based upon these individual examples, and an accurate scientific estimate of the average for a county or district is seldom made. The worst infested fields are, in most cases, those which for some of many reasons which could be given in a detailed report behind the others; that is, late cotton. This makes them

more attractive to the moths and accounts, in part, for the fact that one field is badly injured while surrounding ones are not. The injury in other portions of the cotton region not specially outlined above amounts to less than 2 per cent, and is so scattering as not to demand serious attention, unless, perhaps, in a few isolated exceptional localities.

FOOD-PLANTS.

Corn is well known as its choice food-plant. Cow-peas rank next, and cotton probably third, though there is evidence that if the tomato crop were in as prime a condition later in the season when corn matures the tomato would rank third, and cotton, at best, about fourth. This accounts in part for the slight injury to cotton over most of the cotton belt, where many of the crops just mentioned are planted a second time later in the season, and which, therefore, divides the attack of the Boll Worm on cotton. Experience has abundantly shown that cotton as a food-plant is more a compulsion than a choice. More stress should be placed upon the importance from an economic, entomological standpoint upon the many host plants already on record for this species. In localities where the cultivation of tobacco is being introduced it is to be noted that the Boll Worm abundantly attacks the crop, and care must be exercised in order that its ravages may not attain serious proportions and endanger the progress of the introduction of this crop. In large cities even flower gardens entirely isolated from corn or cotton fields, have been frequently found to be infested with Boll Worm. This can not be accidental, as might be urged, if these gardens were exposed to badly infested fields, and it simply illustrates the reckless, apparently indifferent habit of the female as to the host plant upon which she deposits. Special mention in city flower gardens should be given the Verbena, Geranium, Abutilon, rosebuds, and Jack Beans.

CHARACTERS AND TRANSFORMATIONS.

These have been so fully described heretofore that nothing further deserves special mention in this connection, except the habit of cannibalism among the worms. As for the imagos, former observations as to their diurnal habits have been fully verified the present season. At Arlington, Tex., last August, hundreds were seen flying and feeding freely on cow-peas from 9:30 to about 11 a. m. Though carefully watched, deposition at this time was not observed, and it appeared that they were only breakfasting. Deposition, however, could be frequently noted in the afternoon several hours before sundown.

NUMBER OF BROODS AND HIBERNATION.

As to the number of broods nothing additional need be mentioned at this time. The question of hibernation, however, demands special consideration, and steps must yet be taken to determine more definitely

the facts. Your agent, unfortunately, has been located in regions not especially infested, and it transpires that owing to the scarcity of adults at any season in the localities under observation that hibernating specimens would be rarely found.

There is no question but that many pupæ do not issue in the fall, but remain as such over winter. Many of these even enter the pupa state as early as the middle or latter part of September and remain quiescent until April or May. The decided overlapping of the broods from the beginning of the season is thus easily explained, for doubtless the hibernating moths appear earlier than those issuing from the pupæ in spring.

Observation proves beyond a doubt that a great majority of the destructive brood on cotton in August and September issue as imagos before the close of the season. The facts also prove that instead of the number of worms which might rightfully be expected from these imagos to appear in greatly increased numbers absolutely appear in decreased numbers. This indicated that some of the moths of this brood were bent upon hibernation and refrained from depositing at this time. Indeed, the facts disclosed by the latest observations warrant the assertion that many of the imagos resulting from this destructive brood hibernate. The majority of the worms spoken of in previous reports as found so late in the season are mostly those from the eggs of belated females of the preceding brood and worms whose most rapid development has been hindered by various, perhaps accidental, unfavorable environments. Furthermore, as previously stated, the broods from the very first of the season overlap. Doubtless, therefore, a great portion of the worms found during the latter part of September and later consist also of the lap, so to speak, of the last brood, and should not be counted as a separate brood or even a partial one.

NATURAL ENEMIES.

The cannibalistic habit of the Boll Worm makes it its own greatest enemy, as will be shown under the head of remedial measures. All the enemies noted in Bulletin No. 24 of the Division have been observed again. The same special stress and importance must again be repeated in speaking of the egg parasite (*Trichogramma pretiosa*). Its value can not be overestimated. Among birds the Sapsucker, Crow Blackbird, and Crows deserve special mention. Another species of Robber Fly was noted catching the imagos. Observations upon the habit of ants (*Solenopsis geminata*) earlier in the season makes it absolutely certain that at that season they frequently capture a Boll Worm. They do so mostly when the worm travels or comes out of the ear of corn to molt. They seldom enter an ear of corn for a deliberate search after their victim. Later in the season, when there is a greater diversity of insect life and also vegetable growth, the ant loses special interest in the Boll Worm.

A small Capsid (*Triphleps insidiosus*) is found abundantly on corn silks. It punctures and feeds upon the eggs of Heliothis and probably very young Boll Worms. Many beneficial insects, especially the small Scymnid beetles, are also abundantly found on corn silks. This subject will, however, be treated more fully in a subsequent report.

INSECT RAVAGES EASILY MISTAKEN FOR THOSE OF BOLL WORM.

All of those noted in Bulletin No. 24 of the Division have been observed again, with the additional one of *Thecla pœas*, which, however, had been previously recorded. Among the Tortricidæ, a number of species have been reared on cotton. The habits of the larvæ are well known to be such that it is reasonable to expect that those species of Pyralidæ and Tortricidæ which feed on cotton at all may occasionally in doing so bore a stem or peduncle, or even the bolls, forms, and squares themselves.

Many Hemipterous insects puncture very young forms and squares, or their peduncles, causing the prospective fruit to fall. The mark resulting from the puncture closely resembles the working of very young Boll Worms, and by many planters the latter are held responsible for the injury. To Hemipterous insects is due much of the shedding of cotton in August and September, and ravages are popularly called "sharpshooter" work. The most injurious, and perhaps also the most abundant of the sharpshooters is a large leaf-hopper (*Aulacizes* sp.). *Calocoris rapidus*, *Largus cinctus* are among those also which do much damage. The life-history and ravages of these insects must be reserved for more complete discussion in a subsequent report.

REMEDIES.

The great range of food-plants of the Boll Worm, its habit and method of feeding upon special portions of these host plants, together with the isolation of individuals which necessarily follow such food-habits, make all insecticidal measures of any nature little of or no practcial utility. In the regions designated heretofore as injured probably about 2 per cent or less, the attack by the Boll Worm is divided between so many different crops that the application of any insecticide upon one crop becomes much more expensive for that crop than the injury done by the worm. Furthermore, such measures are inadequate unless applied to all the crops attacked at any specified time in any given locality. For these regions it is evident, therefore, that insecticidal measures are entirely impractical, even though the insecticide be a perfectly efficient one and can be applied with the greatest effect. The same can be said for localities worse infested, though the difference in destructiveness partly mitigates the excess of expense. In any case, the vast areas of cotton to be treated in addition to other crops still make such measures questionable as to expense, aside from the time required during the

busy season when such remedies must be applied. It is the opinion, therefore, of your agent that no insecticidal measures, even though efficient as such, are to be recommended, because from the nature of the case they are burdensome and impracticable. The whole work must be accomplished by preventive measures, such as are hereinafter discussed, and which have been suggested by the food-habits of the species in question, and which by experiment have been found adequate. In this way it was determined that the Boll Worm has a choice food-plant among the long list recorded, and, as will be seen, it has been the effort of your agent to demonstrate the practicability of manipulating this food-plant so as to concentrate the attack upon it, first trapping the worms and then destroying them.

PLOWING.

Fall plowing, as a preventive measure against Boll Worm in slightly infested regions, is not practical as a purely boll worm measure. In badly infested regions it is to be done when possible. The great difficulty with this measure is that the top crop of cotton is seldom all picked timely enough to make fall plowing possible before the rainy, wintry season begins. Due to this fact, it must be urged that plowing be done in spring, as early as it is possible to plow and pulverize the soil. This early plowing, with the cold, rainy weather and occasional frosts, which occur as late as April 1, will insure the destruction of many of the chrysalids. The after-preparation of the soil at planting time will doubtless destroy a small percentage of the surviving pupæ.

Early plowing, in addition to being a boll worm preventive, has its strong advocates among leading agricultural men, who insist that it should be followed as an improved method or practice of farming, since larger and better crops are produced when done.

CORN.

Corn is beyond doubt the choice food-plant of the Boll Worm. From about the middle of April, when the corn becomes large enough for the Boll Worm to work in it, this worm may be found, and continuously so on through the season so long as green corn in suitable condition for food is found. Until about the middle of May or first of June, Boll Worms are rarely found on any other plants than young corn. This being true it is surprising to find that the first brood is so small. From numerous accurate accounts in May and early June, at Shreveport, La., it was found that about 2 per cent of the young corn plants showed signs of Boll Worm ravage, while (due to the change of plants by the worms) *less* than 2 per cent *actually* contained worms.

At this time there is presented the first and most important opportunity for inaugurating preventive measures, namely: to cut out the infested plants and burn them or simply crush the "bud" of the corn

and mash the worm it contains. The small percentage of corn which, even by the severest method, will be destroyed, together with its absolute certainty in attaining the desired end makes this a cheap, effectual, and practical measure to practice at this season of the year.

Some advise the application of oil emulsions to the "buds" of the young corn plants, but the time required to prepare the emulsions, expense of material and apparatus for applying properly the liquids or powders used, again throws it beyond the realm of the practical. There can be no practical advantage gained since no remedy of this nature can be more satisfactory and expeditious than the practice of crushing or cutting out and burning of the "buds" of infested plants as already described.

This preventive measure has the advantage of being inaugurated at a time when labor is not so much needed for other purposes, and hence can be done at a lesser cost and sacrifice. It can be utilized, however, only during the fore part of the season, before the corn tassels, and hence the importance of early action on the part of the planters at the time specified.

As a second preventive measure the cotton field should be so arranged that four or five rows of corn are planted for every forty or fifty rows of cotton, the corn to be planted at a such a time as to be in the prime of silking and roasting ears a week or ten days after the July brood of Boll Worms matures in the regular crop corn; that is to say, at the time when the moths of the destructive August brood which attacks cotton begin issuing. Finding the regular crop corn too near maturity they are compelled to go to the cotton. This occurs from about the first to the middle of August, depending more or less upon the locality. The important point is to have green corn in suitable condition for food at the time when what is called "the destructive brood" goes to cotton. This time, as is well known, varies some in each locality, and can and must be best determined by the farmers of their respective localities. In most cases the result will be accomplished if the trap corn spoken of is planted from about the first to middle of June.

By some dozen experiments with trap-planted corn in various localities, its practicability as well as efficacy has been demonstrated. The female unquestionably selects the trap-planted corn for egg deposition to the practical neglect of the surrounding cotton and all other food plants except cow-peas. The trap-planted corn being reduced to the minimum quantity, the egg deposition upon each individual ear is unnaturally increased. Oftentimes fifteen to twenty-five or thirty eggs were found on the silks of a single ear. The worms fed and found plenty of room in the ear of corn for a time, but as they grew larger they became crowded and began to prey upon each other. When this preying is once started it is carried to such an extent in these infested ears that rarely more than one (sometimes two) of the twenty or thirty worms ever attain maturity. Those even which attain maturity have yet the risk of capture by natural enemies, parasites, disease, etc., to

experience when leaving the ear and traveling about seeking a suitable place for pupation. The number of ears of corn having been reduced to a minimum by trap planting, it is found that the cannibalism induced among the worms reduces those reaching maturity to minimum also. More than a minimum can not be accomplished, whatever be the remedial or preventive measures. It becomes questionable, therefore, whether it is to be recommended that the trap-planted corn be cut and burned so as to destroy the few worms attaining maturity in it, because the value of the corn more than compensates for the small percentage of worms thus maturing.

Again, the numerous fresh corn silks so late in the season seem to be specially attractive to many beneficial insects as suitable resorts, and the egg parasite and many of the other smaller natural enemies of the Boll Worm are found abundantly on these silks and in the ends of the ears. Whether they are attracted by the corn silks being fresh or in search of the objects of their prey, the fact remains that, being thus conveniently quartered in the trap itself, these beneficial insects have more frequent and better opportunities for successfully preying upon the obnoxious insect. Their attack under such circumstances may be said to be artificially concentrated more or less against a specified injurious insect and hence makes them more efficient agents in reducing and assisting in the control of the ravages of that species. A portion of these beneficial insects would also be destroyed by any treatment of the corn looking to the artificial destruction of the Boll Worm. In view of these additional facts it seems best not to urge such a measure.

As to the first preventive measure, some insist that cutting out infested corn early in the season endangers a good stand. In reply it can be said that, much of the corn being drilled in, some is chopped out at the time of the first plowing. At the time of this first chopping a greater proportion of the drilled corn can be left and at the time necessary to most efficiently attack the Boll Worm the portion cut out will be counterbalanced by the slight excess left from the first thinning. But, as already stated, absolute chopping and burning need not be resorted to if care is exercised so that the crushing process be thoroughly done. In that case the worm is destroyed and the plant, as experiments have shown, is not materially injured and still makes a good ear of corn.

To the second, some object that by planting a trap crop in the manner recommended you actually encourage the greatest possible development in point of numbers, that succeeding broods will be proportionately greater, and hence the measure will be worse than no remedy. This has already been partially answered. The trap corn is reduced to the minimum in quantity. This makes a maximum crowded condition which induces the maximum cannibalism in the species and, as already explained, actually makes the Boll Worm its own destroyer. On the other hand, if the trap corn were not planted the moths would of necessity deposit on cotton. Here there is plenty of room and each

individual worm would feed and mature independently; hence no conditions exist to induce their preying upon each other and the maximum number of worms attain maturity.

The results of this preventive measure may be concisely stated to be: First, protection of the cotton. Second, the minimum number of Boll Worms reach maturity without additional expense after being trapped. Third, the first and second are both attained without special cost, in that no money outlay is necessary; no additional labor, since the same would be required were the rows cotton instead of corn; at any rate corn enough is produced to pay for the time and labor required. Fourth, beneficial insects are more or less attracted and their attack concentrated to a certain extent upon a single obnoxious insect. Fifth, the planter thus protecting his cotton is certain to succeed, whether his neighbors attempt equally with him to protect theirs or not, for, having fresh corn in good condition in his cotton, visiting moths from adjoining farms will choose to deposit and the resulting worms will ravage the corn to the practical neglect of the cotton.

COW-PEAS.

For attracting or diverting the Boll Worm moth from the cotton this crop ranks next to corn. The essential point to be attained is to plant the peas at such a time that the crop will be in the height of its blooming period during the latter part of August and September. The Boll Worm moth is very fond of sipping the sweets at the base of the developing blooms and very young pods. The peas answer the purpose best it seems if planted in distinct rows adjoining cotton fields. The growth should be rank and dense, so as to induce the moths to make these rows of dense growth their hiding place. From observation it has been often found that where patches of peas in prime condition were met with during August and September the moths were found there in great abundance and to the practical exclusion of them in the adjoining cotton.

In case it is found that the late-planted trap corn will mature rather too early to be of the greatest value, and especially in regions where drought is apt to prematurely ripen corn, it is to be urged that cow-peas be planted between the rows of corn in time to furnish a continuation of the trap through the rest of the season. In any case it would be well to plant the peas as suggested as an additional attraction along with the trap corn. Care must be taken that only a minimum area is planted, in order that, possibly, other remedial agencies can be applied with the least possible expense if found advisable to do so.

POISONED SWEETS.

The only crop upon which there is a probability of practically utilizing poisoned sweets is that of the cow-peas, planted in limited areas as

previously recommended. With a limited number of rows, and these swarming with Boll Worm moths, a tasteful and attractive sweet well poisoned and thoroughly applied is of some value. A great difficulty is met with in that the liquid applied dries after a short time and whatever moths are to be poisoned in this way must feed soon after the application. This process makes a daily application necessary and of course renders the crop as forage entirely useless. The worst feature, however, is that the poisoned sweet, in order to be an effective poison, must be made so strong that one thorough application burns the foliage and checks the growth of the vines to such an extent that from that time the pea-vines become useless as a crop for attracting the moths. Thus the very purpose for which it was planted is suddenly discontinued. If the brood of moths found at this time issued evenly, this might not be so serious an objection, but, since the brood issues very scatteringly, it is desirable to have the trap a continuous one.

Hence it appears that whatever of benefit is attained by the use of this insecticide it is at too great a sacrifice to make the extensive application of it advisable.

Experience has shown that the poisoned liquid must be actually applied to the food-plant in order to be most attractive, and hence most efficient. If placed in pans or plates or on posts, boards, and like objects, a few moths are trapped occasionally. These catches even seem rather accidental, as the great majority are not attracted and, in fact, the liquid offered in any other locality than upon choice food-plants seems really to form no decisive attraction.

PYRETHRUM.

As already intimated, no insecticide can be of practical utility against the Boll Worm. Much work has been done, however, in making decoctions and various extracts of this powder. The principal points considered were those of determining the difference in extractibility of hot and cold decoctions, hot and cold extracts with oils, such as kerosene or head-light oil. These various extracts and decoctions were always made into an emulsion with oil. The emulsions were then diluted and applied in the usual way. There is some difference in the extent of extraction of the insecticidal properties by hot and cold processes, as also the aqueous and oil extracts. The difference by one of the processes is a decided one, though its practical utility upon this particular species is questionable, except in special cases under certain conditions.

LIGHTS.

Numerous and decisive experiments with lamps for trapping Boll Worm moths were made. Some of these were made under the most favorable circumstances. They all proved the absolute folly of this practice among planters. The moth is not attracted much at any stage

of its existence, and whatever insects are captured are on the whole decidedly beneficial. This practice then is a positive injury, in that it systematically destroys beneficial insects without accomplishing any good as a recompense. This measure, so commonly practiced by planters, should, in view of the decided and constant harm attendant upon its use, be unhesitatingly condemned whenever opportunities are presented for doing so.

INSECT DISEASES.

In order that any insect disease should be most efficient and practical, it is necessary that the pest to be infected be gregarious in habit and travel freely enough to intermingle frequently. For the Boll Worm both of these conditions are found directly by opposites, it being solitary in habit and not traveling about as frequently as most species of worms of economic importance do.

Furthermore, feeding on the inside of the portions attacked their chances for infection through natural agencies and communication with diseased worms are proportionately decreased. Even should a Boll Worm become diseased, in the majority of cases it would die in a boll or ear of corn and the deliquescing portions of the body containing the germs would be absorbed by the rotting or fermenting boll. No other worm, therefore, is ever exposed to infection from it. The solitary habits of the Boll Worm in the midst of suitable plants offering a great plenty of food furthermore insures the most healthy and least accidental condition possible. None of the factors, such as excessive numbers, often resulting in a scarcity of food, thereby reducing the vitality of the worm, enter into consideration in the case of the Boll Worm. All or any of these are conditions which greatly favor the propagation, infection, and distribution of diseases. These facts concerning the numbers and food-habits of the Boll Worm make it impossible to accomplish anything in a practical way with this species, even though the diseases in question were highly contagious and efficacious as destructive agencies. The reason, as already stated, consists in the fact that there are certain conditions required in order that contagious diseases can be introduced and disseminated, and those conditions are wanting in this species.

Again, if there were any contagious insect diseases of economic importance prevalent in the cotton belt they would before this time have made evident their efficacy, especially when it is considered how long cotton and other crops have been under cultivation, and which have been so long ravaged by all the various insects, from some of which we might expect the occurrence and spread of disease. There are such diseases found in the cotton region, and they have been found in such localities as to make infection possible under the conditions as above stated. By observation it has been determined that occasionally Boll Worms do die, and apparently from disease. Whether peculiar to the species or due

to infection from other sources need not be stated here, because the important point is that, in either case, the results thus attained naturally are for this species, probably the best possible even by the coöperation of artificial means. This is in reference only to any possible insect diseases already found in the region where the Boll Worm depredates on cotton.

The only hope then would seem to be the introduction of a foreign disease, or at any rate one not already found in the infested regions. This was thought to be the case with the Cabbage Worm disease. This disease, even in localities in the South where it is prevalent, produces no wholesale exterminative destruction of that species. This disease in itself, then, under the local existing circumstances, is not of that virulent kind necessary in most cases for the infection of a new pest in a new locality. (This is only generally speaking, and is not to be understood as meaning that a disease virulent in one species will be equally so in another, or that a disease mild in one pest might not be virulent in another.) Furthermore, the Cabbage Worm disease is already found in a mild form in some portions of the cotton belt; also, a very prevalent disease of the Cabbage Plusia (*Plusia brassicæ*), and which is probably the same as the Cabbage Worm disease. Small patches of cabbage are found here and there at quite frequent intervals throughout most of the cotton plantations, a condition resulting from the system of small negro tenantry prevalent among Southern planters. Thus every opportunity is offered for the spread of the disease in question in case it were highly contagious and of practical economic importance in this connection. In fact it has been found that the Boll Worm is occasionally found to be diseased. From symptoms and other bacteriological evidence it is now quite definitely determined to be identical with the Plusia and Cabbage Worm disease. It is quite probable, therefore, that these diseases are already doing their work as extensively as is possible under the specially peculiar circumstances already mentioned, and which are such as to quite effectually baffle artificial means.

The importance of the work with insect diseases is not to be underestimated, however. The work which it was possible to do simply demonstrates that by mere contagion and transmission no great and wonderful results are to be obtained. Rather in this case the question becomes one of virulence, and not merely susceptibility to infectious diseases. One acquainted with bacteriological methods knows that these two objects can not primarily be accomplished simultaneously in a single investigation; that is to say that the question of the inefficacy as a practical economic measure by the transmission of any contagious disease must be determined first, and then attention is given, if the pest is found susceptible, to those conditions which might increase the virulence of the disease-producing germs in question. The work, therefore, so far as followed out, is thorough and conclusive, but from the

nature of the case only one portion has been completed. What possibilities lie in the way of experimenting purely with the germ in order to attain the necessary virulence actual experiment will have to demonstrate. In addition to giving attention to the virulence of the disease germs, more study should be given the natural conditions in order to determine whether they may be artificially varied so as to be more conducive to the dissemination of disease.

Above all, the subject ought not to be summarily dismissed, since only a limited number of germs could possibly be experimented with. True, the most hopeful ones were experimented with first, but yet it may transpire that other well-known diseases, not yet tried, may be efficient. The work has really been one of elimination of some specific germs by which it was thought certain desirable results could be attained rather than such as to conclusively demonstrate the impracticability of utilizing insect diseases in the province of economic entomology.

INSECTS OF THE SEASON IN IOWA.

By HERBERT OSBORN, *Special Agent.*

LETTER OF SUBMITTAL.

AMES, IOWA, *December 5, 1891.*

SIR: I submit herewith my report on the more important insects of the season in Iowa. The year has been one of unusual prosperity and excellent crops in the State and the ravages of insects have attracted correspondingly little attention. Observations on some other species than those here mentioned are still in a condition too fragmentary to warrant detailed report.

Very respectfully yours,

HERBERT OSBORN.

DR. C. V. RILEY, *Entomologist,*
Washington, D. C.

The past season has been quite free from any sweeping insect invasion, and, aside from the prominence of plant-lice and their great multiplication upon plums and wheat and the spread of the Clover-seed Midge, there were none to attract special attention or to cause serious alarm. There were of course the ordinary species present in their usual abundance, and there is no doubt that crops were affected in considerable degree; but the loss was not such as to attract unusual attention, and it is of course a matter of regular occurrence for a certain amount of loss to occur in all crops without causing much inquiry from cultivators. In fact, it is the common rule to consider these attacks of little moment, or to believe them too little to be worthy the expenditure of time and money to attempt their prevention. For some crops, and where the cost of application of remedial measures would be large, it is doubtless true, but there are certainly many instances where the expense of applying some remedial agent or the trouble of adopting some method of culture to avoid insect increase would be abundantly repaid.

The White-winged Bibio (*Bibio albipennis*) attracted considerable attention in the spring, appearing in great numbers in many parts of the State, and in a number of cases it was sent in with the statement that it was eating foliage of various plants. The evidence gained, however, did not suffice to establish any case where actual damage was

done to foliage, and we can but think that the flies occurred on plants that had been previously eaten by some other insects and that the work was erroneously attributed to these Bibios when they appeared in such numbers.

Plant-lice were very abundant on almost all kinds of plants, and especially on plum trees did a great deal of damage. The species known as *Aphis prunifolii* was one of the most abundant forms, but other species occurred, and one which was apparently the most common and destructive appears to be referable to *Myzus persicæ*. This is a brown or reddish-brown species, with greenish legs, and it occurs in great abundance on the terminal portions of the twigs and causes very extensive curling and twisting of the leaves, being almost as bad as some gall-forming species in the amount of distortion produced. On this account it is more difficult to destroy with kerosene emulsion than the forms that are less protected, and we found that in some cases the only satisfactory method of reaching them was to dip the worst branches directly into the emulsion and wash them about till all the corners and cavities had been reached. Later in the season the parasitic insects affecting these lice became abundant and their injuries were practically stopped. They can most seriously affect the growth of the fruit as well as the general health of the tree. On a small tree upon which I allowed them to develop for the purpose of watching their progress, they clustered on the stems of the plums, and even on the plums themselves, and the fruit thus infested became much wilted, much of it covered with exuded juices; and even after the lice had been destroyed by parasites failed to recover and make a good growth, some attained only about half size, and were tough and of poorest quality when ripened, while a portion became so withered that they failed to ripen at all. It is evident that the insect should be attended to early in spring, before the lice become numerous and the leaves become curled, as then they can be destroyed very much easier and it will prevent the damage to the fruit.

Two other forms, apparently distinct species and quite different also from *Phorodon humuli*, were observed in small numbers on wild plums, but they have not as yet been referred to any described species.

The Wheat Plant-louse (*Siphonophora avenæ*), which has been abundant in States east of here for a few years past, appeared in abundance in the eastern part of the State this season, especially in the northeastern portion (Jackson and adjoining counties). It seems to have been noticed first only a few weeks before ripening of grain, and for two or three weeks I received a great number of samples. In almost every case, however, the specimens sent were noticed to be in large part affected with parasites, and I could reply that the injury from the lice would probably soon cease. In all cases where I received a second notice from the same place it was to the effect that the parasites had been increasing and that the injury had ceased. The louse is evidently

widely spread. It was seen at Ames in small numbers on oats, but in this case also accompanied by parasites; and while it is probable that wheat and oats may be affected by the louse another year, I think we may depend upon the parasites being sufficiently numerous to prevent serious loss. It would, therefore, not seem advisable to reduce in any degree the planting of wheat or oats or any of the crops that may be affected by this species on account of possible loss from this pest.

The Dogwood Plant-louse, which has been referred to in previous reports, has been observed further and some additional facts secured, but there are still some points of importance to be determined. Eggs of this species and of the Dogwood Aphis (*Aphis cornicola*) were deposited freely on some small dogwood bushes near my office last fall, and I had an opportunity of watching them pretty closely during the spring. The eggs near the ground seemed to pass the winter most perfectly, and for the Schizoneura hatched in fair numbers in spring, a short time before the blossoming of the Dogwood. The insects gathered upon the expanding leaves and also on the blossom buds, and as the latter opened they seemed to gather by preference in the bunches of blossoms clustering upon the stems and at the bases of individual blossoms. Apparently the second or third generation acquired wings, and the Schizoneura then disappeared entirely from the Dogwood. They were not to be found on grasses for some time later, but they would necessarily be scattered widely and difficult to find at first.

During the autumn I received word from a Mr. Bower, of Norway, that his corn had been troubled with plant-lice, and he sent me samples of Setaria infested with Schizoneura, which he said were the same as he had been troubled with on his corn.

Thinking it probable that it was *Aphis maidis* that was affecting the corn, and not the Schizoneura, I requested him to send samples if he could then find them of the lice on the corn roots, and he soon sent me some roots of corn on which were a number of Schizoneuræ resembling in every respect the Schizoneura so common on grass. Some of these were quite evidently acquiring wings, and shortly after I secured from them a winged individual, which agrees closely with *Schizoneura corni*, except that the antennal sensory pits are not so distinctly developed.

As the specimen was mounted while still quite fresh, there is a possibility that the sensory pits had not become as well marked by the rigid chitinous border as in more mature individuals, and while I can not affirm their identity it seems probable that they are the same. If identical with the species affecting the Foxtail, it is evident that there is an important relation between this weed and the corn with which it grows so abundantly. It is certain that we have in the species of Schizoneura here noticed another corn pest that is easily equal to the common corn-root louse in its power to injure this important crop.

The Clover-seed Midge has become a serious pest in many parts of the State, and, while it has been observed before and attention called to

the necessity of preparing for its probable spread here, this year is the first one in which there has been a loss so great as to cause much alarm amongst the farmers. Its most serious ravages have been in the northeastern part of the State, where clover has recently become a quite important and extensively cultivated crop. In many localities from which I have received reports the loss of the clover seed this year has been quite complete. In some cases it appears that the clover has been quite extensively infested with the Clover Thrips (*Phlœothrips nigra*), the slender red larva of which seems to be by some mistaken for the larva of the Midge. The Midge was treated in Bulletin 13 of the Iowa Experiment Station, illustrated with your figures, and it is hoped that this discussion and the quite general attention it has received from the agricultural press of the State will enable the growers of this valuable crop to adopt measures by which to secure good crops of seed.

Another quite serious pest during the year was the Clover-seed Caterpillar (*Grapholitha interstinctana* Clem.), which appeared in this locality in great abundance and caused the loss of a large percentage of the seed, though, since for the first crop there was no effort to secure a crop of seed, the loss was, of course, not so important. This species has been treated in detail by Mr. Gossard and myself in Bulletin 14 of the Iowa Experiment Station and in an article presented to the Association of Economic Entomologists (published in INSECT LIFE), and it is therefore unnecessary to go into detail regarding it here. It may be stated, however, that it has been determined to be three-brooded here and that it was found that, when the clover was cut and stored for the first crop with the larvæ of the first brood still in the heads, all the larvæ perished, and it is deemed a complete method of destruction for the species to cut and store the clover while still in bloom the first time, provided this is quite general, so that larvæ infesting the scattering clover in fence corners and along roadsides are not developed in abundance to lay eggs for the later broods of the season.

The Flavescent Clover Weevil (*Sitones flavescens*) also occurred in considerable abundance here, and it is probably quite generally distributed through the State, since its habits are such as to attract little attention.

The common species of locusts were abundant and in some localities I learned of considerable damage to clover and other crops.

In a number of trials of the hopperdozer plan of treatment for the Grass Leaf-hoppers (which works effectually also for the young of locusts), it was found that a simple flat sheet of sheet iron covered with coal tar on the upper surface and drawn along by means of cords attached at each end was a most effective method of capturing the jumping species not only of leaf-hoppers, but young locusts and a number of other small insects. A paper giving results of these tests was read at the Washington meeting of the Society for the Promotion of Agricultural Science, and published under joint authorship with Mr. Gossard

in Bulletin 14, Iowa Experiment Station. The most important results may be here stated. In an experiment upon a plat of grass land a portion was treated with the tarred sheet on May 29; the remainder of the plat, or rather a corresponding portion on the opposite side of a narrow roadway, was left untreated. On June 9 a trial by running the tarred sheet over a strip 3 rods in length on each plat, it was determined that by actual count the leaf-hoppers were more than five times as plenty on the plat that had been untreated as on the treated plat. And July 2, when the hay was cut on each plat, the yield from the treated plat was 34 per cent better than that of the untreated plat.

On June 20 the tarred sheet was tried on another part of the lawn, and, "in moving 55 feet with the dozer, the number of leaf-hoppers taken was estimated by counting the insects on three sections of the dozer, each 6 inches long and extending the entire width of the dozer. The counts were 183, 319, and 226, respectively, which averages 243 for each section, or 4,131 on the whole pan. At this rate about 376,000 insects would be caught per acre.

"Another test was made at the same time, dragging the dozer over 66 feet of lawn. This time five sections of 6 inches each were counted off and averaged, instead of three, which resulted in giving 2,805 insects on the dozer, or 213,089 would be taken on an acre."

In previous reports I have given some estimates as to the number of these leaf-hoppers that may occur on an acre of grass land, and it will be seen that these trials not only give confirmatory evidence as to the great numbers of these pests that live in grass, but show that they can be captured successfully by the hopperdozer plan. Since the latter trials were made in hot weather and when most of the insects were winged, it was impossible to capture all of the hoppers, and it is probable that the actual number of hoppers on the land averaged well up to 1,000,000 per acre. By selecting best conditions, it will be possible to capture a larger percentage, and the profit of securing even half of the hoppers in the grass will, I believe, well repay all expense and trouble of treatment.

A very interesting occurrence of the year was the remarkable increase of a parasite (*Apanteles glomeratus*) affecting the common Cabbage-worm (*Pieris rapæ*).

About the 1st of May I received from you some parasites imported from England, but they were already issuing from the cocoons and there had been no cabbages planted at the time in this locality, so that my only hope of getting them established here was to place them on Black Mustard growing wild, and even here I had little hopes of getting them established, as *P. rapæ* had only begun to appear in the imago and there was little possibility of larvæ being ready in time for oviposition of Apanteles. About the 1st of August I was somewhat surprised to have brought to me a number of *rapæ* larvæ with cocoons of a parasite that resembled exactly the Apanteles. When the imagos issued

they proved to be, so far as I could see, identical, and my opinion was confirmed by referring the specimens to your office. The Apanteles had been most abundant in the gardens of a Mr. Gregory, a gardener near Ames, but about 3 miles from where the Apanteles had been introduced, and it seemed almost impossible that they could have become so widely distributed and so abundant in so short a time. I made careful inquiries of Mr. Gregory, and found that the parasite had been first observed by his wife in the fall of 1890, but in small numbers, and at the time supposed to be an injurious species, and all that were observed had been destroyed. During the summer just past, however, she had seen the larvæ issuing from the caterpillars and rightly appreciated their beneficial nature. They became so abundant in Mr. Gregory's garden that he told me they had entirely destroyed the cabbage worms on his place, and they also multiplied extensively in the cabbage patches on the college farm, so that there will probably be very few of the cabbage worms another season and even if they appear in some numbers the parasites should be so thoroughly distributed as to be able to keep them entirely in check.

While this occurrence of the Apanteles by some previous introduction makes it impossible to say with certainty whether any were established as a result of the introduction of last spring (and the probabilities were against a successful issue in this case) there is the strongest proof of the ability of the species to thrive and to successfully reduce the numbers of *Pieris rapæ*. It would be of interest to ascertain the source from which they were introduced, but nothing could be learned of any probable introduction direct from any distant point and it seems most likely that the species has simply spread through its own powers of dispersal from other parts of the country where it has been present. It would seem to be a very easy species to distribute from one point to another, but for the Northern States it would seem more easy to introduce in the latter part of the season, as the imagos issue in spring too early to find *rapæ* larvæ ready for them to oviposit upon. Mr. Gregory informed me that the parasites were noticed issuing from the pupæ as well as from the larvæ.

The Apple Maggot, which reports indicated as common in some sections of the State last year and which it was feared might prove troublesome to our orchardists, has not been heard from the present season, although the apple crop has been a large one. Should it make no further appearance it would seem to strengthen the idea that it does not thrive in this region, perhaps on account of unfavorable soil, a condition that may be viewed with much satisfaction by our fruit-growers.

REPORT OF ENTOMOLOGICAL WORK OF THE SEASON OF 1891.

By F. M. Webster, *Special Agent.*

LETTER OF SUBMITTAL.

Columbus, Ohio, *October 10, 1891.*

Sir: I herewith submit my annual report for the current year. My last report preceding this related to the development of the Hessian Fly, and especially as showing the desirability of late sowing as a means of warding off the fall attack. It seems, however, that where the carrying out of this advice leads to a procrastination in the preparation of the ground it is likely to lead to injurious effects, where wheat is to follow clover. I have, therefore, prepared the accompanying report in order to show the nature of another class of depredators, and how it is, doubtless, possible and practicable to follow out the directions as to late seeding and still avoid contact with this second evil.

Yours very respectfully,

F. M. Webster,
Special Agent.

Dr. C. V. Riley,
U. S. Entomologist.

INTRODUCTION.

During the fall of 1890, after the rendering of my annual report for that year, I was engaged in the study of various insects, notably those affecting young growing grain. On February 2, 1891, I started on a tour of investigation through Arkansas and Texas, in order to continue work begun by me in 1886, relative to the occurrence and effect of various species of Simulium infesting the streams of the valley of the lower Mississippi, and also to investigate the depredations of the Grape Curculio in northwestern Arkansas. From the 20th of February to the 1st of April I was in Texas engaged in further studies of Simulium and grain insects. A report of the work of this trip has been forwarded you and published in Insect Life. Soon after my return, in accordance with your direction, I visited the farm of Dr. I. W. Chamberlain, at Hudson, Summit County, Ohio, to investigate an occurrence of the Clover Hay-worm. A report of this and further investigation of the species involved has been forwarded to you. Further investigations

into the habits of some destructive species of Tipulidæ were made, and a report, illustrated by drawings, was presented to you for publication.

A report on observations upon many species of Coleoptera has also been prepared and forwarded to you for publication. In pursuance to your instructions, I secured a large number of eggs of *Lachnosterna*, especially of *L. fusca*, *L. gibbosa*, and *L. hirticula*, and, after carefully watching the development of these eggs, placed the larvæ in breeding boxes, and have colonies of larvæ of each of these three species, reared from the egg, and at present thriving nicely in confinement.

On April 23 I received from you a consignment of *Semiotellus nigripes*, and, in accordance with your instructions, placed the larger portion in a wheat field seriously affected by the Hessian Fly, and the smaller portion were placed on fly-infested plants, under a cover of Swiss muslin. Later I received from Prof. Bruner a second consignment, which was promptly forwarded to Prof. Charles E. Thorne, Director of the Ohio Agricultural Experiment Station, who placed them in two fields of wheat near Columbus, Ohio. In regard to the success in introducing these parasites, I am not yet able to report. I did not rear adult *Semiotellus* from those released among grain, under cover, but this is in no way to be construed into a failure to colonize them in the field. When received many had emerged from the flaxseeds, and some of them had perished, and the larger portion of those remaining were placed in the fields. At the time of the release at La Fayette, Ind., the adult Hessian Flies and native parasites were abroad in great numbers. The field where they were placed had been seriously attacked by the fly during the preceding autumn, fully one-half of the wheat plants being affected. That portion of the field where colonization was made has not been molested since, except to remove the crop. Wheat was again sown on the larger portion of this field and also on another adjoining, also in wheat last year, so that at present there are two fields of wheat growing within 20 yards of the spot where the liberation took place. Therefore, while I am unable to say whether or not the parasite has become established, I can say that it has had every opportunity to do so, and a failure in this case would almost prove conclusively the imposibility of colonization. The number of living parasites placed was too small to show immediate results, and, therefore, time must be given for them to multiply before expecting absolute proof of colonization. With regard to those released here I am not so hopeful, as wheat, owing to dry weather, did not germinate quickly after being sown, and, I fear, may have come too late to afford hosts for the *Semiotellus*. Both fields where the parasite was liberated still remain uncultivated.

On July 1 of this year I severed my connection with the experiment station at La Fayette, Ind., and formed a similar connection with the Ohio Agricultural Experiment Station located at this place, a change which was approved by yourself.

Since locating here several destructive insects have demanded atten-

tion. The Wheat Midge, *Diplosis tritici*, appeared in limited numbers and was investigated in accordance with your instructions. A bulletin was issued by me from the station dealing with chronological data in regard to the pest, and a report submitted to yourself relating to this and some other closely allied species.

Many inquiries in regard to the Hessian Fly have been received, and in order to meet a popular wish my report of 1890 to yourself, and appertaining to this species, has been received and adapted to a station bulletin, which was issued in November of the present year. This, I think, will afford the desired information to the farmers of the State and reply to a vast amount of inquiry, which would otherwise have to be answered by letter.

The indications are that several important pests will demand attention next year, and, with your approval, considerable time will be spent in becoming acquainted with the State and the people, with a view of securing assistance from the farmers and affording the same in return. The facilities offered by the station will enable me to push some investigations which I have not been able to do before.

REPORT ON SEVERAL SPECIES OF CRANE-FLIES INFESTING MEADOWS AND PASTURES, AND WHICH MAY ALSO PROVE INJURIOUS TO WHEAT.

Any extended study of the species belonging to this group of insects, the Tipulidæ, is impeded by many obstacles, owing, first, to the great difficulty of securing a proper determination of the species involved, and, second, to the fact that they are among farmers to a considerable extent associated with cutworms, the larvæ being known as cutworms and the adults as "cutworm flies;" so that it is not only a difficult task to indicate the exact insect, but equally so to secure accurate data with respect to its habits in the fields. In England these insects have long ravaged fields of young wheat sown after clover, but in this country such attacks have not often been observed. With the increasing popularity of clover-growing, both for pasture, meadow, seed, and fertilizer, it would appear that we are on the verge of a new era with respect to the effects of these insects in our clover fields; and even now one who watches them carefully and notes the numbers of adults which are often to be observed about our clover fields can not help but suspect that they are working an injury which we either fail to observe, or, observing, attribute the loss occasioned thereby to other causes. So far as grain crops are concerned, the indications are that the American husbandman will have little trouble in preventing serious ravages in his fields. What the future of our clover lands is to be, especially if allowed to remain intact for a number of years, is yet to be seen. Of the species studied, there is not one the ravages of which can not be almost entirely prevented in young wheat by plowing the ground during late August or early September, and there is every reason to believe that if

the fall growth of clover is kept mowed or grazed off during September and October little trouble will likely follow from the depredations of the larvæ the following spring. Some species, notably the ones studied in the Indiana fields in 1888 and 1890, are two brooded, the eggs being deposited in spring and fall, while *Tipula bicornis*, which was reared from the field at Ashland, Ohio, and a species near or identical with *Tipula angustipennis* Loew, are probably single brooded, ovipositing during late September and October only.

TIPULA BICORNIS Loew.

On May 17, 1888, we received the following note from the editors of the *Anderson Herald*:

ANDERSON, IND., *May 16, 1888.*

We send you by today's mail a bottle with some worms which are taking the place of cutworms in our county. We send them to have them named or to find out the name.

THE HERALD COMPANY.

We visited the locality on May 23, but could learn of but one infested field, this being on the farm of Mr. J. C. Beesom, located about 3½ miles from the city of Anderson. This field consisted of 22 acres of underdrained clay loam, with the soil of the depressions darker colored, the surface, however, being nearly level. The field for the two preceding seasons had been devoted to red-clover pasture, but not pastured during the last year after about August 1. After this date there sprung up a rank growth of clover, and, besides, a great number of Rag-weeds (Ambrosia). During March of 1888 the clover had been almost totally killed, the owner thought by the weather. About April 16 Mr. Beesom began to break the field, and then discovered myriads of these larvæ, which were new both to him and his neighbors. At this time, from a square foot of ground he took two hundred of the larvæ, and did not dare to plant his fields from fear of these worms destroying his crop. On May 16 he found them still in the earth in immense numbers, and noticed that a considerable percentage had disappeared—doubtless pupated.

When I visited the field fully 90 per cent were in the pupal stage, their numbers fully confirming Mr. Beesom's statement as to the number of larvæ, the lower and darker colored spots being the worst infested. There were, at the time of my visit, very few adults to be found in the grass along the edges of the field, but in the sod, which was that of Blue Grass, no larvæ or pupæ could be found. Although the two stages were pretty generally distributed over the whole area of the field, they were especially abundant under clods, turf, or half-covered bunches of weeds and other débris. On the level plowed ground the pupæ could be detected by round holes which they occupied in a vertical position. Under the clods this feature was not so noticeable; although in these cases they seemed to favor the edges of their coverts.

The country was originally thickly wooded, but has for a long time been cleared up, except frequent groves, which are usually pastured. The infested field was one cleared by pioneers many years ago.

The advanced stage of development to which the insects had already attained precluded the possibility of thorough study in the field, especially of the larval habits, and hence we were obliged to be content with a few and a good supply of pupæ, with which we returned home.

After the general habit of these insects the pupa occupies a vertical position in the earth, and the adult, just prior to emerging, pushes from one-half to two-thirds of its body above the surface. In this position a large number of pupæ were placed in breeding cages and the result most carefully watched. The first adult, a male, appeared on May 25, and did not burst from the pupa until after the latter had been protruding from the earth for several hours. The pupa case first bursts along the head and prothorax, and the head and shoulders of the adult first appear. Until enough of the body has been delivered to clear the tips of the wings, egress is brought about by muscular extension and contraction of the abdominal segments. After the wings are free, but while still in its vertical position, the imago changes its tactics, and begins to rock gently backward and forward, drawing up the legs slightly at each backward motion, until they are finally withdrawn from the case, and the now nearly emerged insect bends forward with the nearly empty pupa case and crawls forth. In the case of the female, loaded down with her burden of eggs, the assistance of the male is often required to finally extricate her.

On the 26th a large number of adults of both sexes emerged in the breeding cage, followed on the 27th by still greater numbers, the males in the majority; but hardly to the extent indicated by Mr. Beesom in the following letter, received a few days later:

ANDERSON, IND., *May 29, 1888.*

Mr. F. M. WEBSTER: According to promise I will give you a history of the worms and fly. On May 26 the flies were very numerous around the fences, multiplying each day until the 29th, when the field was swarming with the "gran'daddy long-legs." On the same day there was some not yet hatched, but not many, and some were just coming out. I watched their habits, and think from appearance there was about one female to one hundred males. The female is full of eggs when hatched; has about three hundred eggs of a jet black color. I saw the male helping the female out of the shell. He would do this by standing upright with the female pushing back and forth. In this case the shell would be half way out of the ground. As soon as he would get her out he would impregnate the eggs. This is about all I can tell you now.

Yours etc.,

J. C. BEESOM.

Soon after emerging, sometimes within a few hours, the female begins her work of oviposition. Three newly emerged females, placed separately in glass tubes, produced respectively 297, 282, and 289 eggs. In confinement, these eggs were thrown off at the rate of from 3 to 10 per minute.

Authorities differ as to the mode of oviposition among the Tipulidæ; and it is not improbable that there may be a difference of method in different species. Curtis opined that the British species oviposited while on the wing, and Miss Ormerod says that *Tipula oleracea* Linn., oviposits in or on the surface of the ground, while Dr. Riley states that he has witnessed the oviposition of an American species, *Tipula trivittata* Say, and the eggs are forced into the ground by means of a double pair of valves, something as in the case of our common locusts.

In the species under consideration, the terminal abdominal segment of the female is much more obtuse than in some other of the American species, ending in a pair of broad, concave valves or plates, whose office appears to consist in holding the eggs in place and assist in directing them to within the reach of a second pair of organs. With the female standing on a horizontal surface, in a natural position, the egg appears to pass down the oviduct with the concave surface downward, but on nearing the terminus of the oviduct the posterior end of the egg is thrown under and forward, thereby bringing the concave side upward, and lying, seemingly, directly under a small liguliform plate which is attached only at its base. The apical portion of this triangular plate appears to fit the concave side of the egg, which is prevented from going too far backward by the anal valves previously mentioned. It is here that the second pair of plates or valves, apparently the most important appendage, is called into play. This is situated just beneath or a little back of the triangular plate, their bases having very nearly a common origin, and is composed of two movable valves, or claspers (whose base is broadened into a thin flap, which, coming upward at the sides, forms a receptacle for the egg) which, when closed together, form a hemispherical cup having almost the exact form of one-half of the epicarp of the hickory nut; and each of the two parts, when opened, as faithfully represent one of the valves of the epicarp. When the egg is in position on the triangular plate these valves are pressed against and about it, inclosing it on all sides, leaving only a portion visible along the apex; and dropping downwards slightly, but gently, the egg is projected forth with a slight snapping sound, seemingly propelled in much the same manner as one would eject the pit from a ripe cherry by pressing it between the thumb and forefinger. Whether the liguliform plate follows the valves in this downward movement, or not, I could not determine, but think such is the case, as the egg is not projected directly backward, but deflects considerably downward. The movements of oviposition are made so quickly that it is exceedingly difficult to observe the exact action of the parts, and therefore I give them as they appeared to me. Further observation may require a slight revision.

I have an idea that the two elevations at the base of the liguliform plate, which is drawn as seen from beneath, may serve to keep the egg from slipping backward and may also assist in pushing it forward. At the base of plate, on the under side, are two loose ap-

pendages fixed at base and middle, forming, as it were, a sort of basal pocket for each of the claspers. The exact use of these I can not understand, but suspect they assist in some manner in holding, or, possibly, propelling the egg, as, in Pachyrrhina, they are reduced to what appears to me to be a mere cushion.

I wish it distinctly understood that I did not witness oviposition, except under artificial environments, and therefore it would not be best to take too much for granted. But, in view of the mechanism of the organs of oviposition, and the manner in which they are called into play, together with the fact that in the breeding cages the eggs were scattered about, without the least indication of a desire to secrete them, it seems at least doubtful about this species ovipositing in the ground, though it must be confessed the organs of oviposition have a strange resemblance to those of migratory locusts.

The egg.—The egg is 0.8^{mm} in length, and from 0.3 to 0.4^{mm} in breadth, elongate-ovoid, strongly concave on one side, of a jet black color and highly polished.*

The larva.—The larva is about 20^{mm} in length, and in maximum diameter is about 3^{mm}; head retractile, small and horny, whitish in color, and spotted with black; antennæ yellowish; body strongly wrinkled, transversely, especially the posterior segments. In the young larvæ there are on most of the segments sparsely placed, stout, curved bristles, but in the mature larvæ these are more frequently missing. The first segment is small, the others increasing to the eighth; thence decreasing to the twelfth. The first seven segments are much smoother, but not as clearly defined as the last five. The terminal segment is very obtuse, and armed above with a row of four stout hooked spines, curved posteriorly, beneath which are two large spiracles, and below each of these is a short, fleshy spine, curved upward. General color, dingy white.

The pupa.—The pupa varies in length from 13^{mm} to 18^{mm}, and in breadth from 3^{mm} to 5^{mm}; head, with eyes, distinct; the antennæ is insecurely attached along the breast, short, eleven-jointed, the last joint strongly constricted at tip; horns prominent, knobbed, curved, moderately distantly separated at base, with an intervening median black ridge; thorax quite prominent, and rotund above; wings extending to anterior margin of first ventral segment; legs extending, usually, to posterior margin of first ventral segment, where they all terminate together, forming a sort of flap, easily detached from the segment and from each other. The abdomen is usually rather strongly depressed, widening from base to third segment, gradually tapering from thence to tip. Excepting the terminal, all of the abdominal segments are provided with a transverse row of short spines on the dorsal surface, and likewise on the ventral surface, with the exception of the first and second, which have, instead, two large and two small spines, one of each placed on either side of the middle. The terminal segment ends with a cluster of closely placed, fleshy pustules, which appear to be more or less retractile. Back and above these are two fleshy spines, eight in number. The lateral margins of the abdomen are wide and thin, armed with a lateral row of spines, two on each segment. General color of pupa, dull, dingy brown.

As clover was seriously injured throughout the West during the winter and spring of 1888, any attempt to estimate the injury occasioned by these worms would, of necessity, be mere guesswork.

*Eggs very similar to, if not identical with, these were described some years ago by Dr. Riley, to whom they were sent by Prof. S. A. Forbes, he having found them in the stomach of the Catbird in Illinois. (See Am. Ent., vol. III, p. 24.)

That this species is double-brooded there is no reasonable doubt, later observations showing that the eggs of the fall brood are deposited principally during September, the insect wintering over in the larval stage and finishing this stage in early spring, its period of development being a little later than the following species, although the two may be found abundantly at the same season, the Pachyrrhina appearing first and seeming to be well advanced in the work of oviposition by the time this begins to appear in noticeable numbers.

Respecting natural enemies, Mr. Beesom had observed great numbers of crows and "bee birds" hovering about this field almost constantly, and he was quite positive that they were engaged in the destruction of the larvæ. From what has already been stated, it seems probable that the adults are, to some extent at least, destroyed by the Catbird. Of the probable insect enemies, *Pterostichus lucublandus* was particularly abundant, and Mr. Beesom at once pointed them out as the most numerous in the field, and particularly where the larvæ were then congregated. *Harpalus pennsylvanicus*, *H. caliginosus*, and *Pterostichus femoralis* were also present in considerable numbers, as were also the larvæ of some species of Harpalus and Platynus, these larvæ being especially abundant in places where the pupæ of the Tipula were massed.

PACHYRRHINA sp.?

Late in April, 1890, news came to me of the depredations of a new insect pest in fields of young wheat near Farmersburg, Sullivan County, Ind. This time the depredators proved to be the larvæ of a species of Pachyrrina, but whose depredations were very much like the preceding; a visit to the locality on the 26th, and especially to the fields of Mr. T. H. Kendall, revealing the nature of the depredator and effect of its ravages. The insect was at that time most abundant in the pupal stage, these pupæ, after the manner of the Tipulidæ in general, occupying vertical cells in the ground. Larvæ were, however, present in considerable numbers, both in the earth and on the surface, the day being rainy, and not only about the wheat plants, but also about stray clumps of timothy, of which there were a considerable number scattered over the field among the wheat. For reasons which will appear further on, the numbers present in both stages did not correspond at all with the reports of Mr. Kendall, nor with the amount of damage clearly attributable to the pest. The most seriously injured fields were those which had been in clover the previous year.

Of two fields adjoining each other, one sown on oat stubble, the other on clover sod plowed early in October, the latter was damaged fully 50 per cent, while the former had escaped uninjured. Another field a short distance from these, also in clover last year but plowed late in August, was damaged only about 15 per cent. A clover field adjoining the first two had been completely ruined, but this might have been in part due to the winter, although the insect was present in abundance.

A close inspection of the most seriously injured fields showed large areas of grain totally destroyed, while other areas among them were little injured. The plants themselves had not been thrown out by the frost, but were well fixed in the soil. The day was rainy, and many of the dead plants had a green appearance like that of wetted hay, and did not at all resemble those killed by frost or freezing, indicating that they had withered.

Mr. Kendall stated that up to the 1st of February his wheat was in fine condition, but after that time it began to die, and continued to do so rapidly until about the first week in April, since which time the depredations had gradually ceased. Soon after the trouble began he had observed the larvæ in myriads both above and below ground, but they worked below, not cutting off the plants, but apparently wounding them and sucking the juices. In working about just beneath the surface of the ground they raised ridges like those made by moles, but about the size of straws, and the earth immediately about the plants was often worked up as if by ants or earth-worms.

A large number of larvæ and pupæ were secured and taken home, in order that I might be able to study the method of feeding in the former, secure adults, and watch the oviposition of the females, which, I judged, might differ from those previously studied in case they proved to be of a different species. While collecting this material, not only many dead pupæ were noticed, but larvæ also, lying on the surface of the ground, many of which had turned black wholly or in part, after the manner of diseased cabbage-worms. This led to the suspicion that they had been attacked by a fungous disease, which had reduced their number and consequent injury. While all living material was, on my arrival home, placed in a breeding cage and thus kept out of doors, nearly all of the pupæ were destroyed, almost entirely, I believe, by this fungoid enemy, which Dr. J. C. Arthur informs me is undescribed, and for which he proposes the manuscript name *Empusa pachyrrhinæ*. One larva constructed its cell in the earth in the breeding cage and transformed to the pupa, but the next day this pupa worked itself upward out of the cell and was found lying on the surface dead, and covered with spores of Empusa. How much this fungus had to do with the stopping of depredations of the larvæ on the wheat it is, of course, impossible to say, but it must have destroyed a large percentage of the pest.

The first adult appeared in the cage on the 28th, two days after removal from the field. Other adults emerged so very sparingly, and at such long intervals, that no opportunity was offered to secure fertilized eggs or note the ovipositing habits of the females. The first of the only two females reared was nearly dead when a male emerged, and, though fertilized, died without ovipositing, and the male refused to pair a second time, leaving the second female without a mate, she dying before a second male emerged. Two females and four males

were all the adults secured from the material brought home, the others, as I believe, having been destroyed by the Empusa previously mentioned.

The same species was found in abundance in clover fields about Lafayette during the whole of the month of May, eggs being secured on the 28th from a female taken in the field. We have this year reared adults which appeared June 4. About the 10th of August males began to appear again in great abundance, and both sexes were observed on the 15th, and by the 27th they seemed to be in the height of the ovipositing season; but the females stubbornly refused to oviposit in confinement, and it was only by securing a female while laying her eggs in the field that I secured an additional supply, though I saw a female which had been caught in a spider snare depositing her eggs freely. By the 20th of September the species had nearly disappeared, only spent females being seen, though the present season, near Columbus, Ohio, one was observed filled with eggs as late as the 22d. It seems, therefore, that the ovipositing seasons are, as a rule, from about May 1 to June 15 and from about August 10 to September 25, the period covering about six weeks.

The organs of oviposition in this species are very different from those of the preceding, giving to the posterior segment of the females a very different appearance. Instead of the broad valves we have a pair of chitinous forceps while the lower plates are produced with the prolongations vertically flattened, and the base forms an elongate receptacle. The liguliform plate is less robust and partakes more of a cartilaginous than a chitinous nature, its office evidently being in part sustained by the teeth with which the interior basal part of the second pair of plates is provided. The two pair of plates, when not in use, close up and form a slender prolongation of the last abdominal segment. The egg differs from that of the preceding species by being smaller and having five distinct grooves, presumably allowing the teeth of the lower plates to gain a stronger hold on the egg itself, and thus reënforcing the liguliform plate, which, as in the preceding, seems to fit into the concavity of the egg. The manner of oviposition is as follows: The egg, leaving the oviduct, drops into the second or lower pair of claspers and under the small liguliform piece, the concave side upward. Here it seems to be held in place while the upper organ or plate is drawn backward, the lower being at the same time slightly advanced until the two flattened prolongations drop in between the two upper ones, when there is a sharp click and the egg is thrown forth at an angle of probably 40 degrees. As with the preceding species, the rapidity of the movement renders it difficult to observe accurately or to determine the exact source of propulsion. The females of this species utterly refuse to oviposit in confinement, and it is only by capturing them in the fields, after they have probably begun oviposition, that one is able to secure eggs. Even here, however, we have not been able to witness undisturbed oviposition, and therefore not able to observe whether or not they use

the combined organs with which to place the eggs in the earth, as their general contour would indicate might be the case. More especially does this seem possible as the preceding species, whose organs of oviposition do not seem fitted for placing eggs, oviposit freely in the breeding cage. Besides being grooved, the eggs of these Pachyrrhinæ are smaller and less robust than those of *Tipula bicornis*. The number of eggs which the female produces is also uncertain, as I have not been able to secure accurate data on that point.

On May 7, 1891, I received a number of Tipulid larvæ from Mr. D. F. Wise, of Ashland County, Ohio, with the statement that they were present in one of his fields in myriads, and he was afraid to plant corn therein through fear of their destroying his crop. The owner described the infested field as having been devoted to wheat three and two years previously, yielding about 20 bushels per acre; was seeded to clover, and last year a crop of hay was removed. This spring, however, the clover had disappeared and the entire field of 14 acres furnished only feed enough for twenty-two ewes and their lambs. From these larvæ I reared, June 4, a male and female of this species. Mr. Wise wrote me later that he had observed these worms in his clover fields, and had noticed unaccountable injuries thereto for the last nine years, but thought the intruders were ordinary cut-worms. About the first of April, this year, he began tiling his field, and on the following morning found the bottom of the ditch, though covered with water, was swarming with these larvæ, and the fact of their living in water raised the suspicion that they were not true cut-worms. On May 16, nearly six weeks later, he wrote that those larvæ were still living in the ditch.

When I received the larvæ from Mr. Wise they were placed in a large glass with considerable earth and a clover plant, but no drainage. After waiting a considerable time for other adults to emerge from the larvæ, I concluded that the remainder had died, and paid no further attention to the glass in which they had been placed.

Tipula costalis Say.

Early in July an examination of the earth in the glass mentioned above, now nearly a solid mass, showed several larvæ, and, what was more surprising, they were still alive. During my removal from Lafayette, Ind., to Columbus, Ohio, and the rearrangement of things, this glass accidentally became filled with water, and remained so for nearly two weeks, when, judge of my astonishment on examining the contents, ten larvæ were found alive and completely submerged in the water, one floating about with its posterior upward. The larvæ were at once removed and placed in a flower-pot, in which a fresh clover plant was placed, and this kept watered. Nothing appeared until September 20, when a male emerged, followed on the next day by a female. These were kept together, and, though copulation took place, the female stubbornly refused to oviposit, and died without furnishing me

with a single egg. The same day on which the latter of these two adults emerged, while riding along the road, myriads of both sexes were observed. They were also received from Mr. J. M. Jones, of Dunkirk, Hardin County, who wrote under date of September 19, stating that they had appeared about the 15th and were literally swarming. He also called attention to the popular notion of their originating from cut-worms. All facts taken together indicate that this species is single-brooded, the eggs being deposited during late September and early October. Mr. Wise states that the larvæ of these Crane-flies are most abundant in low, grayish-black soil, and where the ground is the wettest, and that during heavy rains they appear to work nearer the surface of the ground. He also states that to his knowledge they have never injured corn planted in these fields, and the present season has shown no exception.*

From the foregoing it seems that our clover fields are menaced by at least three species of Crane-flies, one of which is known to be, under certain conditions, exceedingly destructive to wheat, while the other two may rest under grave suspicion. In a former report to this Department I clearly showed the desirability of sowing wheat late in the fall—the exact time depending upon the locality—as a protection against the fall attack of the Hessian fly. It seems now that though sowing should be deferred, plowing, in cases where wheat is to follow clover, should be done late in August, or at least before the middle of September, in order to escape injury from the larvæ of Crane-flies.

Besides the enemies of Crane-flies already given, I have observed an ant, *Aphænogaster fulva*, attack and drag away a living female of Pachyrrhina, and in addition to the bird enemies given by Mr. Beesom the following is a list of birds found to have preyed upon these insects in Illinois (see Bull. State Lab. Nat. Hist. Ill., No. 3, pp. 104–135):

Species of bird.	No. of birds examined.	Ratio of food composed of Tipulidæ.
Robin	114	.01
Catbird	70	.05
Wood Thrush	22	.12
Alice Thrush	11	.08
Swainson Thrush	11	.04

* Since the above was written letters have been received from Mr. Wise stating that the corn in the field infested by the larvæ of this species did not yield half a crop. The plants were thrifty until in August, when they suddenly ceased to grow, with the result stated. Roots sent me show unmistakable signs of attacks by insects, such attacks not being made until after the plants had become well rooted, after which a vast number of small roots had been thrown out to replace the larger ones destroyed. While, therefore, it is as yet too much to say that *Tipula costalis* is a corn-destroying insect, there seems a prospect that future study may prove it to be such.—F. M. W.

REPORT UPON THE GYPSY MOTH IN MASSACHUSETTS.

By SAMUEL HENSHAW, *Special Agent.*

LETTER OF SUBMITTAL.

CAMBRIDGE, MASS., *December 7, 1891.*

SIR: I herewith submit my report upon the Gypsy Moth (*Ocneria dispar*) in Massachusetts, undertaken in accordance with your instructions.

Yours truly,

SAM'L HENSHAW.

Prof. C. V. RILEY,
U. S. Entomologist.

This insect, a native of Europe, is mentioned in the American Entomologist for February, 1870 (Vol. II, p. 771), as accidentally introduced into New England (Cf. also Riley's Second Missouri Report, 1870, p. 10). Though noted at that time as "spreading with great rapidity" it was not until November, 1889, when Prof. C. H. Fernald, of the Hatch (Massachusetts) Experiment Station, issued a special bulletin, entitled "A dangerous insect pest in Medford," that the species attracted general attention.

Prof. Fernald's bulletin, aided by notices in the daily press, led to the mention of the insect by Governor Brackett in his message to the State legislature in January, 1890; he said: "A new enemy is at present threatening the agriculture, not only of our State but of the whole country. I refer to the Gypsy Moth (*Ocneria dispar*), a European insect which has recently appeared in the State. They are said to attack almost every variety of tree as well as the farm and garden crops. They are now confined to a very small area in Middlesex County, but have become acclimated and are spreading with great rapidity. If their eradication is to be attempted, immediate measures are of the utmost importance."

A hearing was given by the Committee on Agriculture and an act was passed by the legislature authorizing the appointment by the Governor of a Gypsy Moth Commission to consist of not more than three members.

The following is the act:

[CHAP. 95.]

AN ACT to provide against depredations by the insect known as the *Ocneria dispar* or Gypsy Moth.

Be it enacted, etc., as follows:

SECTION 1. The Governor, by and with the consent of the Council, is hereby authorized to appoint a commission, of not exceeding three suitable and discreet persons, whose duty it shall be to provide and carry into execution all possible and reasonable measures to prevent the spreading and to secure the extermination of the *Ocneria dispar*, or Gypsy Moth, in this Commonwealth; and to this end said Commission shall have full authority to provide itself with all necessary material and appliances and to employ such competent persons as it shall deem needful; and shall also have the right in the execution of the purposes of this act to enter upon the lands of any person.

SEC. 2. The owner of any land so entered upon, who shall suffer damage by such entry and acts done thereon by said Commission, or under its direction, may recover the same of the city or town in which the lands so claimed to have been damaged are situate by action of contract; but any benefits received by such entry and the acts done on such lands in the execution of the purposes of this act shall be determined by the court or jury before whom such action is heard, and the amount thereof shall be applied in reduction of said damages; and the Commonwealth shall refund to said city or town one half of the amount of the damages recovered.

SEC. 3. Said Commission shall have full authority to make from time to time such rules and regulations in furtherance of the purposes of this act as it shall deem needful; which rules and regulation shall be published in one or more newspapers published in the county of Suffolk, and copies of such rules and regulations shall be posted in at least three public places in each city or town in which said *Ocneria dispar* or Gypsy Moth shall be found by such Commission to exist, and a copy thereof shall be filed with the city or town clerk of each city or town. Any person who shall knowingly violate any of the provisions thereof shall be punished for each violation by a fine not exceeding twenty-five dollars.

SEC. 4. Said Commission shall keep a record of its transactions and a full account of all its expenditures, in such form and manner as shall be prescribed by the Governor and Council, and shall also make return thereof to the Governor and Council at such time or times and in such form as shall be directed by the Governor and Council. The expenses incurred under this act shall be paid by the Commonwealth, except claims for damages by the entry upon the lands of any person and acts done thereon by said Commission or by its direction, which shall be paid as provided in section two of this act.

SEC. 5. The Governor and Council shall establish the rate of compensation of the Commissioners appointed under this act, and the Governor may terminate their commissions at his pleasure.

SEC. 6. Any person who shall purposely resist or obstruct said Commissioners or any person or persons under their employ while engaged in the execution of the purposes of this act, shall be punished by a fine not exceeding twenty-five dollars for each offense.

SEC. 7. It shall be unlawful for any person to knowingly bring the insect known as the *Ocneria dispar* or Gypsy Moth, or its nests or eggs, within this Commonwealth; or for any person knowingly to transport said insect or its nests or eggs from any town or city to another town or city within this Commonwealth, except while engaged in and for the purposes of destroying them. Any person who shall offend against the provisions of this section of this act shall be punished by a fine not exceeding two hundred dollars or by imprisonment in the house of correction not exceeding sixty days, or by both said fine and imprisonment.

SEC. 8. To carry out the provisions of this act a sum not exceeding twenty-five thousand dollars may be expended.

SEC. 9. This act shall take effect upon its passage.

This act was approved March 14, 1890, and the Governor named W. W. Rawson, of Arlington; Pearl Martin, of Medford, and J. H. Bradley, of Malden, as the Commissioners; they organized March 22, 1890. The appropriations for the work were authorized in the following act and resolve, approved April 2, 1890, and June 3, 1890:

[CHAP. 157.]

AN ACT making an appropriation for the extermination of the insect known as the *Ocneria dispar* or Gypsy Moth.

SEC. 1. A sum not exceeding twenty-five thousand dollars is hereby appropriated to be paid out of the treasury of the Commonwealth from the ordinary revenue, for the purpose of meeting expenses authorized by chapter ninety-five of the acts of the present year providing against depredations by the insect known as the *Ocneria dispar* or Gypsy Moth.

SEC. 2. This act shall take effect upon its passage.

[CHAP. 66.]

RESOLVE relative to the insect known as the *Ocneria dispar* or Gypsy Moth.

Resolved, That there be allowed and paid out of the treasury of the Commonwealth a sum not exceeding twenty-five thousand dollars, in addition to the twenty-five thousand dollars authorized by chapter ninety-five of the acts of the present year, for the purpose of continuing the work of the Commission appointed under said act in preventing the spreading and securing the extermination of the *Ocneria dispar* or Gypsy Moth in the Commonwealth.

Of this sum of $50,000 only $25,514.31 was expended during the work of the season.

Naturally the first work of the Commission was to determine the limits of the infested region. The only data at hand stated that the Ocneria was confined to an area in the form of an ellipse about a mile and a half long by half a mile wide situated in Medford. It was at once discovered that the Ocneria was abundant in many other localities. By the end of May, 1890, the infested region was stated to cover a district 4 miles wide and 16 miles long.

At the end of their term of service (February 25, 1891), the Commissioners stated that the infested territory was confined to Everett, Malden, Medford, the westerly parts of Chelsea, the northwesterly of Arlington, the easterly edge of Winchester, and a few scattered localities in Somerville, in all an area of about 50 square miles. The district being determined, an inspection of trees, shrubs, fences, etc., followed, all infested being marked with a piece of red flannel. Attention was first given to the masses of eggs and their destruction was pressed energetically until the first days of May, when spraying began. Lighted kerosene torches were used to destroy the egg masses. They were applied to the eggs in the positions in which they were found.

Many acres of brush land were burned over. The work of spraying began May 12 and was practically finished July 23. Mr. C. A. Longley was in charge of the work and the insecticide used was Paris green, one pound in 150 gallons of water. During the season about 2 tons of Paris green were used and 70,000 trees sprayed. The spraying equipment consisted of a cask mounted upon a wagon, a force pump with stirrer, 100 to 200 feet of hose and nozzles. Four men accompanied each

team. A means taken to prevent the spread of the Ocneria was the employment of officers with authority to stop and examine every team, carriage, horse car, or person passing outside the limits of Malden and Medford and to examine the same. Though the utility of this work was doubted from the first it was continued until most of the larvæ had transformed into pupæ. In the fall months the Commission also did some work destroying the egg masses.

On February 25, 1891, Governor Russell, acting under authority of Section 5, Chapter 95, acts of 1890, sent a message to the Legislature and to the Executive Council removing the Commissioners for cause and placing the work in charge of Messrs. W. R. Sessions, N. S. Shaler, and F. H. Appleton. All the new appointees are connected with the State Board of Agriculture and serve gratuitously. See INSECT LIFE, Vol. III, pp. 472–474 for the act passed by the general court in 1891

and for the rules and regulations of the Committee. Early in March the Committee placed the field work in charge of Mr. E. H. Forbush, to whose tireless energy most of the good results are due.

Starting with the information as to the limits of the infested region given by the Commission of 1890 it was soon discovered that the Ocneria was abundant in many places in addition to those reported. It can now be stated to occur in Marblehead, Salem, Swampscott, Lynn, Lynnfield, Reading, Wakefield, Saugus, Revere, Chelsea, Charlestown, Cambridge, Somerville, Watertown, Waltham, Belmont, Arlington-Lexington, Burlington, Woburn, Winchester, Stoneham, Melrose, Mal, den, Everett, and Medford. There is a great difference in the abundance of the Ocneria in the various localities, and the bulk of the damage has been confined to Everett, Malden, Medford, and Arlington.

The main lines of work this year have not been different from those adopted the preceding year, though in some details there have been changes. The greatest attention has been paid to the destruction of the eggs. It was thought that the method of burning the eggs *in situ* adopted last year was injurious to the trees and that many of the eggs were not only not destroyed but scattered about. Consequently such as were in exposed situations on trees, fences, etc., were cut out and burned.

The danger of scattering the eggs by this method would not seem to be very much less than by burning them in place.

For egg masses that could not be collected and destroyed another method has been employed. This is called blazing, and is applied chiefly to stone walls, trunks of old trees, heaps of stone, etc.

The apparatus used consists of a cyclone nozzle attached to a pole, a brass rod passes through the pole, a line of hose connects the pole with a tank, from which crude oil is pumped. A blaze thus started, a running fire is secured, and it soon penetrates all the cracks and crevices. This seems a useful and effective way of destroying many eggs not readily reached by any ordinary method. The committee and their superintendent place their greatest hope of the extermination of the Ocneria upon the destruction of the eggs; to an impartial observer, however, the probability of the detection of every mass of eggs scattered over an area of 50 square miles seems very small, especially when it is remembered that they are placed in almost every conceivable situation upon the trunks, branches, and even the leaves of trees and shrubs, upon fences, the sides of houses, under stone walls, piazzas, board walks, etc. So far as my observations go the search for the eggs has been carefully done, though I have found masses of the eggs after the inspection of the locality had been completed. Many similar cases have been reported; they should be considered as a criticism of the method rather than an indication that proper care had not been exercised, for as Prof. Fernald says, "it is not at all probable that one will find all the egg masses even with the most careful searching on the trees in a small orchard."

Owing to a lack of time or insufficient force some of the most badly infested districts were not inspected during the spring search.

Early in May the committee turned their attention to destroying the larvæ by spraying with Paris green. After the visit of the United States Entomologist, about the middle of June, a nozzle that would throw a mist spray was obtained, an ordinary garden nozzle having been used up to that time. A tendency to cover too much ground in a given time was noticed, and also much unevenness in the effectiveness of the spraying. It is quite possible, however, that this unevenness due to inexperience was inevitable under the circumstances.

Though this indiscriminate spraying undoubtedly did much good in lessening the ravages of the cankerworms, Orgyia, etc., it certainly in-

creased an already existing strong feeling against the use of Paris green, and many land-owners did all in their power to annul or neutralize the work of the committee.

To prevent the larvæ ascending the trees two methods were used; the one consisting of a band of printer's ink and the other of strips of bagging. While the larvæ were unable to cross the band of ink, its composition was such that it required renewal every few days, and its application left each tree with an ugly girdle and possibly did injury to the trees. Insect lime would have been a desirable substitute. The strips of bagging served as a hiding place for any wandering larvæ, which were collected and destroyed.

The work of inspecting vehicles passing out of the district was discontinued after a trial of about two months; information as to the chief direction of travel from the infested district seems to have been the only result of this work.

Considerable work was done in trimming trees, clearing away and burning rubbish, and in cementing holes in trees, fences, etc. The habits and natural history of the Ocneria as observed here differs somewhat from the same in Europe.

I have no evidence that it is double brooded. The winter is passed in the egg state. There is much irregularity in the hatching of larvæ, they were first observed on April 15, in 1890, and on the 20th of the same month in 1891; they were abundant May 20. In 1891 larvæ hatched as late as June 17 and by the 10th of July young larvæ, fully grown larvæ and all intermediate stages, pupæ and imagos were found. The young larvæ on hatching scatter, feed chiefly during the night, resting during the day upon the leaves, branches, etc. The tendency to wander increases with growth. In confinement they cluster together, eat more continuously and strip the twigs in a more methodical manner than observed in those feeding at large. Pupæ were abundant July 10; this stage usually lasts from twelve to twenty days though several have given imagos after eight and nine days.

The males fly readily but the females are excessively sluggish; even when blown by the wind they have a marvellous faculty of getting to the ground or to the sheltered side of a tree or fence. The greatest distance I have seen one fly was a little short of 6 feet. The moths are not readily attracted by light.

As is well known the Ocneria is a most general feeder. I have found it on Linden (*Tilia*), Horse Chestnut (*Aesculus*), Maple (*Acer*), Pear, Cherry, Plum (*Prunus*), Rose (*Rosa*), Apple (*Pyrus*), Ash (*Fraxinus*), Elm (*Ulmus*), Hickory (*Carya*), Birch (*Betula*), Alder (*Alnus*), Oak (*Quercus*), Beech (*Fagus*), Willow (*Salix*), and Poplar (*Populus*). It has also eaten, in confinement, Virginia Creeper (*Ampelopsis*), Dogwood (*Cornus*), and Fringe-tree (*Chionanthus*). It refused Grape (*Vitis*). Other records include Quince, Apricot, Pomegranate, Hornbeam, Hazelnut, Lime, Norway Spruce, Larch, Fir, Azalea, Myrtle, Corn, Wisteria,

Cabbage, Chestnut, Arbor Vitæ, Yew, Ilex, Pine, Mespilus, Peach, Millet, Plane-tree, Hawthorn, Mulberry, and Strawberry.

An interesting point in connection with their ability to feed on so great a variety of plants is the facility with which they can be changed from one food-plant to another. I have fed a number of larvæ all from a single mass of eggs, the food-plant of every one of which was different, and with others have changed the food-plant every day during their entire larval history. The larvæ of Ocneria are frequently found with the eggs of a Tachinid attached to them. Generally there is but a single egg, though sometimes two, three and four have been observed; they are usually on or near the head. In most of the cases that came under my observations the Ocneria moulted before the eggs of the Tachinid hatched. Two of the Tachinids which pupated August 19, gave imagos September 2. Another fact which must lessen the value of this Tachinid as a destroyer of the Ocneria is a habit the larvæ have of rubbing the head against some hard substance. This was observed several times, and in some cases the eggs though not detached were injured. Although I can not state that *Pimpla pedalis* is parasitic upon the Ocneria it has been very abundant in the infested region this year, and I think it very probable that it will be found among the parasites of the Ocneria.

Doubtless many birds will be found feeding upon the Ocneria. At this time there are but two species, the Yellow-billed Cuckoo and the Black-billed Cuckoo (*Coccyzus americanus* and *C. erythrophthalmus*), that I can name as aiding quite materially in the destruction of the larvæ. Among invertebrates the following can be named: *Cicindela 6-guttata*, *Camponotus herculaneus*, *Sinea diadema*, an undetermined Syrphus, and Chrysopa, *Lithobius forficatus;* also the following spiders: *Epeira strix*, *Steatoda borealis*, *Lycosa* sp., *Drassus* sp., *Agalena nævia*, *Phidippus galathea* (*mystaceus*), *Epiblemum scenicum*, *Marptusa familiaris*, and *Thomixus* sp.

While the original creation of the Commission and the subsequent transfer of the work to the State Board of Agriculture were warranted by the nature of the emergency, it was undoubtedly a mistake to appoint men to look after such important work—work demanding, in the words of the appointing power, "prompt, judicious, and energetic action"—who were already more than occupied with other work. The fact that they were appointed with the distinct understanding that their services should be given gratuitously, while not equivalent to saying that their services would be slight, does indicate that they would be secondary to more important affairs.

And while it is only just to the present committee to state that they have devoted more time to their work than could have been asked or expected, it is interesting to note that one of them is now in favor of at least a per diem compensation, and recently so testified before a legislative committee.

The destruction of the Ocneria being primarily an entomological question, the need of an entomologist acting in constant concert with the committee would seem to be undisputed. That there was no such person employed is proved by the fact that the Committee allowed the most important month for spraying to pass without procuring the most improved apparatus.

The attention drawn to this insect should lead to the passage of a general law against insect and fungus pests. A State officer acting under the direction of the State Board of Agriculture could recommend to farmers and others the means to be used against noxious insects and fungi, and the law should be so framed that penalties could be imposed upon owners who took no precautions after due notice had been given. Some such legislation would soon bring the orchards and shade trees of Massachusetts into a more creditable condition, and the introduction of the Ocneria could be looked upon as a benefit rather than an injury.

REPORT OF APICULTURAL EXPERIMENTS IN 1891.

By A. J. Cook.

LETTER OF SUBMITTAL.

AGRICULTURAL COLLEGE, MICH., *November 15, 1891.*

SIR: I beg leave to submit the following report of experiments in apiculture for the season of 1891. It will be noticed that in this report the plural pronoun has been used, and this is eminently proper, as Mr. John H. Larrabee has not only had charge of the work directly, but has aided very much by offering many excellent suggestions.

Respectfully, yours,

A. J. COOK.

The past season has been very unfavorable for apicultural experiments, not only in Michigan, but throughout the entire country. The secretion of nectar from clover, and indeed from nearly all other honey plants, was very meager indeed. In Michigan the season has been peculiar for drought and cold. The exceptionally cool temperature has been very general throughout the country, while in many sections there has been an excess of rainfall. As the honey production has been very light in nearly all sections, it would seem that the low temperature might be the chief cause of the light honey crop for this season.

SPECIAL PLANTING FOR HONEY.

The experiments of this season have been a continuation of those of the past three years. The aim has been to determine whether it would be profitable or not to plant solely with the view of increasing the acreage of honey plants, and so the production of honey.

As the expense of planting, use of land, and danger of failure to secure a crop are considered, we easily see that we can not hope for a profitable return unless the plants have value besides for honey, are sure to give us honey despite the season, to grow when planted even though drought confronts us, to grow and thrive with but little care after planting, and to hold their own against insects, drought, and all discouragements.

THE CHAPMAN HONEY-PLANT.

As this plant has been very highly extolled, was lauded by a special committee selected to examine it, and has been widely distributed by Government, it was considered a desirable plant with which to experiment.

Quite a large area was planted to this *Echinops sphærocephalus* on two successive years. The soil was clay loam. The ground was fitted as well as for corn, the seeds sown in drills, and cultivated the first season. The plants came well and grew remarkably well. They never blossom until the second season, so there are no returns the first year. This is the first serious objection to them as honey plants. The second summer the plants blossomed full. They were very vigorous and the blossoms very numerous. The bees seemed to visit the flowers very freely. Mr. Th. W. Cowan, a celebrated apiarist of England, said to me some years since regarding this plant: "The bees hang around it persistently, but I could never see that the gain in honey in the hive was ever perceptible." I found the same true here. Actual weighing showed very little gain, nor was our honey crop superior to that of our neighbors with no Echinops within range of their bees. The plants blossom from July 20 to August 20, at a good time and for a long season, if they were of any value.

In the winter we cleaned the seed. Although previously warned, and consequently protected by veils and gloves, the barbed awns sought out our eyes and skin everywhere. The pain caused was intense. All who aided in cleaning the seed were in agony for several days. Even this alone would or should preclude this plant from general use. To my disappointment, these plants seemed to exhaust themselves this first season. The next year there were almost no blossoms, but new plants came up very thickly from seeds scattered the previous autumn. This failure of the plants to afford blossoms the third season from planting I know is not always true, as I have had blossoms for four years from plants on sand. It is probable that when the plants are very luxuriant and are allowed to seed we can only count on a single crop of blossoms. This season, the fourth from planting, we had a rather feeble growth of plants. The grass and weeds fought with the Echinops for the land and succeeded in so far that we secured a very meager quantity of bloom, and apparently no valuable results in our honey crop. Thus the failure to blossom the first year, the failure to secrete any large amount of nectar, the failure in many cases to bloom the third year, and the inability to compete with grass and *other weeds* without expensive aid, makes it certain that if any plants will pay for honey alone this is not one of them.

THE ROCKY MOUNTAIN BEE PLANT.

This plant (*Cleome integrifolia*) has again been tried for the third year. That it is a very superior honey plant and blossoms at just the right

time, all through July and August, is certainly true; but it is not a very pushing plant, and the seeds will not germinate unless exposed to the weather for months. Thus it is necessary to plant in August or September of the previous year if we expect a fair stand of this plant. When this is done, unless the land is very free from grass and weed seed, the latter will get the start, and our Cleome will be choked out. Thus I think we have proved that Cleome is only suitable for planting in waste places, when from its beauty and excellence as a honey plant it rivals even the Sweet Clover.

There seems little doubt but that we should secure much honey from this plant were we to take the necessary pains to secure a full stand of acres of vigorous plants. But this can be done only at large expense, too large to ever pay in actual practice.

RAPE.

Knowing from the study of small plats, that have been grown here for years, that the Rape (*Brassica campestris* var. *colza*) and the mustards seemed especially attractive to the bees, and knowing that the former was regarded very highly by many farmers for pasture, especially for sheep, it was thought advisable this season to sow several acres of ground to this plant. Part of the land was light sand and another part clay loam. As the plant blooms in about four weeks from seeding, we sowed it the middle of June.

We are likely to have a severe drought at this time, and this year was no exception. The seed failed to germinate well, especially on the sand. By the middle of July both fields were in full bloom, yet the bees did not swarm on the flowers, as we had hoped they would, nor did the honey product seem affected by the near presence of the rape. I am not sure that we gained any special advantage from it. If we did it was not perceptible. The weather for nearly all the time was very cool.

I do not believe it will ever pay to sow rape specially for honey. If it is sown for pasture, as recommended in England and Ontario, there will be but little bloom, and so, even in favorable years, the beekeeper would receive but small advantage. If grown for seed there would be a profusion of bloom, and in favorable seasons the honey product would be without doubt greatly augmented.

It is certainly wise for the apiarist to encourage and even urge the planting in his neighborhood of any and every useful honey plant, as Rape, Alsike, Clover, and Buckwheat. Often from unfavorable weather they will not afford nectar, still they may bridge the whole distance between failure and success.

SWEET CLOVER.

Bee-keepers have long known that Sweet Clover (*Melilotus alba*), though often failing to secrete nectar, is still one of our first honey plants. It not only yields in favorable seasons very abundantly, but

the honey from it is very white and excellent. This plant is known as Melilot, Sweet Clover, White Melilotus, and Bokhara Clover. While one or two authorities, Prof. Thorne, of Ohio, and Prof. Tracey, of Mississippi, have stated that it possesses value as a forage plant, the consensus of opinion throughout the country is that this luxuriant plant possesses little value to feed either green or as hay. It has been sown in many parts of the country by beekeepers and others in waste places and along roadsides, and in such locations has frequently added decidedly to the honey product. It is a beautiful plant, with a sweet perfume, and may well replace Ragweed, Mayweed, Smartweed, etc., along our highways.

We sowed several acres of this plant this spring, six on sand and three on clay. The drought came on and the young plants upon the sand withered and died. On the clay the catch was only partially successful, but the plants have stooled and we think will produce a fairly good crop of bloom. It is our purpose to see if it may not be a valuable silage plant. It surely produces abundantly. If it will be appetizing as silage so as to possess value to the farmer then from its double value as a silage plant and a most excellent honey plant it may well be grown by the bee-keeping farmer and may be urged conscientiously by the apiarist upon his neighbor farmer. This plant, like nearly all the clovers, is a biennial, and so we must wait till next year to complete our experiment, when we hope to prove that Melilotus is valuable for silage.

Our conclusions thus far are that special planting for honey will never pay. Unless we can find a plant that will always secrete nectar, and, as seasons of honey failure occur in all countries, we conclude that none such exist, and we certainly can not afford the expense and labor.

We think our experiments warrant this conclusion. That it may and often has paid well to scatter seeds of Sweet Clover in waste places there is no possible doubt. Along the roadside this plant may well replace such utterly worthless and ugly plants as Ragweed—species of Ambrosia, and Mayweed—*Maruta cotula*. The first year's growth and the second till after bloom are very handsome. After bloom the dry ugly stock may be cut, when the undergrowth from the seeds of the present year will make a pleasing border to the road. Cleome may also be planted in all waste places. This has been done with excellent results in Minnesota and Wisconsin. It is a very handsome plant, and like Sweet Clover is easily subdued if not wanted. In case this is desired the seeds should be planted early, as early as August or September, else they will not germinate well the following season.

BEES AS FERTILIZERS.

Spraying fruit trees in early spring to prevent the ravages of various insects is becoming very common. Spraying trees while in bloom is very likely to poison the nectar and destroy the Honey Bee. This has been done in several cases. Not only have the mature bees been poi-

soned, but the brood has also been destroyed. The fact that doubt has been expressed in reference to such poisoning, and the fact that even legislators have expressed disbelief in the value of bees to horticulturists, led to the following experiments:

Bees in cages were given foliage sprayed with sweetened water, and in other precisely similar cages the same sweetened water in which London purple had been mixed in the proportion of 1 pound to 200 gallons of water. The bees in the first cages were in no way affected, while the others were all dead in thirty-six hours, and in many cases in twenty-four hours.

Thus we have positive proof, both in the field and from laboratory experiment, that bees are very susceptible to the poisonous effects of the arsenites, and that to spray fruit trees while in bloom always endangers the lives of all bees that visit the flowers. In the other experiments we desired to learn how important bees were in the work of fertilization and cross-fertilization of plants. Trees examined in May while in bloom showed twenty bees to one of other kinds of insects. On a rather cold day, such as are likely to occur in time of fruit bloom, hundreds of Honey Bees were found at work on the apple bloom, while almost no other insects were to be seen.

In the following experiment the same number of blossoms were counted on each of two adjacent branches on various trees, shrubs, and plants. In each case one lot was marked by a tag giving the date of the experiment, while the other was surrounded by cheese cloth just before the blossoms opened, thus precluding the visits of all insects from this lot, except such very small ones as Thrips, Jassids, etc., which were so small that they would escape notice. After the blossoms withered the covers were removed, and two weeks later examination was made to note the results. The following table gives the results of the this experiment:

Variety.	Date covered.	Date uncovered.	Number of blossoms.	Date examined.	Fruit set.	Fruit set on comparison.	Remarks.
Apple	May 4	May 25	40	June 11	0	15	
Do	May 4	May 19	75	June 11	0	3	
Crab Apple	May 4	May 19	200	June 11	0	3	Affected by the frost.
Apple	May 4	May 19	160	June 11	2	9	
Pear	May 4	May 19	140	June 11	0	7	
Cherry	May 4	May 19	300	June 11	9	119	
Strawberries	May 18	June 16	60	June 22	9	27	
Do	May 18	June 16	212	June 22	80	104	
Do	May 18	June 16	123	June 22	20	36	
Raspberries	May 26	July 6	2 canes	July 6	.....	.....	As many perfect berries as on canes not covered.
Do	May 30	July 6	184	July 6	93	160	
Do	May 30	July 6	1 cane	July 6	.....	.....	No difference by count or appearance of fruit.
Red Clover	June 12	July 30	10 heads	July 30	0	191	
White Clover	June 5	July 30	10 heads	July 30	0	541	

In the case of the strawberries boxes covered with cheesecloth were set over the plants. As these stood on the ground, of course insects may

have come up from the earth. Thus a few insects may have gained access to the flowers, as we note that the plants were covered for about a month.

We see that in every case the fruit was greatly lessened, if we except the two cases of raspberries. In several cases, notably those of the clovers, no fruit or seeds were secured in the covered specimens. The strawberries seem less affected than any other of the plants, except the two cases of the raspberries. This may be owing, as suggested above, to the presence of insects that could come up from the earth beneath the plants. Perhaps strawberries, when the blossoms contain both stamens and pistils, are less dependent on insects than many other fruits. The two cases of raspberries are curious. We can not explain them. The fact is very apparent that fruit-growers are nearly or quite as much interested in the presence of bees as are the bee-keepers. Pomologists then may well join hands with the apiarists in demanding and securing a law making it a grave misdemeanor to spray fruit trees while they are in bloom.

EXPERIMENTS IN BREEDING.

That bees, like all other organisms, are greatly subject to variation is known to every bee-keeper. That they can be greatly improved by careful selection is equally well understood by all observant queen-breeders. The mating habits of bees are such as to make experimentation in breeding difficult, but the obstacles are not unsurmountable. We are working to overcome them and to develop a superior strain of bees by judicious crossing and selection. This is slow work, and we can hope for decided results only after a long period.

Our stock is from Syrian and Carniolan, and, as the former predominates, we have this season bred very largely from Carniolan. Several of the most prolific queens are selected, and it is our purpose to use the ones from these that winter the best the coming winter for breeding next season. We shall try to test the Punic bees and, if they show superiority, introduce some of this blood.

Besides the above, several other experiments of a miscellaneous character have been conducted which are of more or less interest.

CONSUMPTION OF HONEY IN THE SECRETION OF WAX.

This experiment was performed that we might determine how much honey it requires to enable the bees to secrete 1 pound of wax. Three colonies were taken, which we will designate as No. 1, No. 2, and No. 3, the bees of which weighed $6\frac{1}{4}$, $8\frac{1}{4}$, and $5\frac{1}{4}$ pounds, respectively. No. 1 was given a virgin queen and no comb or honey. No. 2 was given a virgin queen and empty combs. No. 3 was given a laying queen and empty combs. A vigorous colony on scales during the experiment gained $4\frac{1}{2}$ pounds. The bees did not fly from these hives as vigorously as from hives not in the experiment. The feeding doubtless had some-

thing to do with this. No. 3 seemed to gather more honey and to be in a more normal condition than Nos. 1 and 2. No. 3 had a full frame of brood nearly ready to seal at the expiration of the experiment. August 15, 28 per cent of the bees in No. 1 had wax scales, while none of No. 2 that were examined had wax scales. The experiment commenced August 11. The bees of each colony were fed 21 pounds of honey. The experiment lasted ten days.

	No. 1.	No. 2.	No. 3.
	Pounds.	*Pounds.*	*Pounds.*
Weight of bees August 11	6¼	8¼	5½
Total weight August 11, 7 p. m	35	43	40¾
Total weight August 22, 7 a. m	46	62	61½
Gain in weight in ten days	11	19	20¾
Total amount of feed given	21	21	21
Weight of honey extracted August 22	9	16½	18
Loss in honey fed	12	4½	3
Gain in weight in ten days	11	19	20¾
Wax secreted by No. 1	*11¼		
Pollen in combs at end	½	1½	†4
Total weight removed at close	10¼	18	22
Apparent deficiency due to scales	¾	1	1¼
Gain in weight of No. 2 over No. 1	8 pounds		

* Ounces. † Weight of young brood and pollen.

$11\frac{1}{4} : 8 = 16 : x$, or about 11 pounds honey to 1 pound of wax.

This experiment gives 11 pounds of honey as the amount necessary to secrete 1 pound of wax. Huber decided, as the result of careful experimentation, upon 20 pounds as the amount, while Viallon and Hasty concluded that the amount was less even than we have found in the above. Of course, in such experiments there will be errors, as from the conditions the colony is not kept in an absolutely normal condition. No brood-rearing should be allowed, and so virgin queens were given to colonies. Whether the bees work with less vigor physically or physiologically when a laying queen is replaced by a virgin, I can not say.

We thought over the experiment a long time and concluded on the above as the nearest approach to the normal of any plan we could decide upon.

The results from colony No. 3, which was normal, show that the error was not great. A repetition will add correctness to the experiment. We shall hope to repeat it another year. We believe the results are not very wide of the truth in actually normal conditions.

DO WORKER BEES FEED THE DRONES?

Several times in the past we have tried experiments to determine whether the worker bees fed the drones, as they do the queen and larvæ, the albuminous portion of their food. We know that drones are great honey-consumers. It is reasonable to suppose that they are equally great consumers of the albuminous food or bee bread. There is little or no doubt that the upper head glands of the younger worker bees secrete the liquid that digests the pollen. These glands are large and turgid in the young or nurse bees, shrunken and inactive in

old worker bees, and absent in the drones and queens. From analogy, then, we would reason that the queen, drones, and older workers—the bees that do the outside work—as well as the larvæ, are fed the digested pollen, which is rich nitrogenous food. If this is true, and there can be no longer any doubt, then we have double reasons to reduce the number of drones in the apiary, to save honey and pollen and also the energy of the nurse bees.

To prove this point we repeated the previous experiments of caging drones in the hive behind a single wire gauze, a double wire gauze, the space between being more than 0.26 of an inch, which is the maximum length of the worker's tongue, and a perforated zinc cage. Honey was placed in each cage in such a manner as not to daub any bees. In the first kind of cage the bees could reach the drones through the single gauze, though at some inconvenience, so as to feed them the digested food. In the second cages this would be impossible and the drones could only get honey for food. In the third cages the drones were confined, but could be and were freely visited by the worker bees, as the workers could pass freely through the zinc, which the drones could not do. In the single wire-cloth cages the drones appeared somewhat neglected after several days. They lived from four to seven days, while in the cages with double wire cloth none lived over three days, and they generally died inside of forty-eight hours. Those confined in cages covered with perforated zinc lived for over two weeks and would probably have lived much longer.

These experiments agree very closely with those previously tried.

THE CONDUCTIVITY OF WAX.

It is a common practice among bee-keepers to confine the bees in winter to a portion of the hive, thus to economize heat and the better to preserve the health and vigor of the bees. Some experiments by Prof. Gaston Bonnier, of Paris, France, seem to show that the combs are as good a protection as is a division board, especially if fastened to close-fitting frames, or, as in nature, to the side of the hive. To test this matter we used a common division board, a close-fitting empty comb, and a close-fitting comb full of honey These were used successively to confine the bees to one part of the hive and leave a vacant space on the other side. A thermometer was suspended in this empty space and the temperature observed several times daily, and estimates made with reference to the outside temperature. The averages showed no difference with respect to the division board and the empty comb, but did show a slight difference in favor of the comb full of honey. We then used an empty hive, dividing it into three compartments by means of a division board of wood and of empty comb, and again by the use of the wooden board and a full comb of honey, the combs being made equally tight-fitting with the wooden division board. A small lamp was placed in the middle apartment and thermometers in the other

two. The hive was placed in the cellar where the thermometer marked a temperature of 58° F. The temperature in the compartment of the hive with the lamp was 110° F. As between the board and empty comb there was no difference in the temperature in the outer compartments, while with the comb of honey the temperature was 4½ degrees cooler beyond the division, showing this to be a poorer conductor of heat and a better protection for the bees than either the board or empty comb.

Thus we see that for winter protection special division boards are unnecessary if we but use close-fitting frames of comb or make such frames close fitting in the winter time. It is also apparent that combs full of honey are better as nonconductors than are empty combs. Thus in nature bees are well fortified against the cold of winter, as they are combs walled in on each side by several full combs, which are fastened to the side of the receptacle. We also see that close-fitting frames or else frames with wide or close-fitting top and end bars are better to protect the bees than are the common Langstroth frames. It is easy to see from the above why box hives and hives with close-fitting frames, like the Heddon, are well arranged to secure success in wintering.

CELLAR VS. OUTDOOR WINTERING.

In the more northern latitudes of the United States bees winter better as a general thing and consume less honey in the cellar than on the summer stands, even though packed or kept in chaff hives. The last winter was an exception. Our bees in chaff hives wintered out of doors consumed less honey apparently and were certainly in better condition in the spring than were those wintered in the cellar. If we could be sure of such mild winters as the last two have been, cellars for wintering would certainly go out of use. Hence it is to be feared that many bee-keepers will become confident, forgetting the cold and disastrous winters of the past, and soon there may come a return of the severe cold and the mortality among the bees will be as terribly disastrous as in the worst winters of the past. It is well to prepare for war in time of peace. The wise bee-keeper will arrange each autumn for a severe winter. Then he will be safe in any event.

PACKING ABOUT THE HIVES IN SPRING.

We have proved for the past two or three springs prior to that of 1891 that to pack closely about the hives with excelsior or other poor conductors, confining the same by a large, well-covered case set around the hive, has paid exceedingly well for the expense of the case and the labor of adjusting it and the packing. The past spring we could see no such advantage. The unprotected colonies gained as rapidly and were as strong in May as were those in the hives that were protected. The explanation is not far to seek. The last spring was very mild and bees

suffered very little in any kind of hive. Usually we have many very cold bleak days in April and early May; then protection pays exceedingly well. The principle is a good one, "It pays to protect." Occasionally we have a spring like that of 1891, when it is unnecessary, but we should conduct our business for the general, not the exceptional.

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